ARCV
UPUB
A33.001
1969/1973
Vol. 3

UNIVERSITY OF MARYLAND

AGRICULTURAL EXPERIMENT STATION
COLLEGE PARK, MARYLAND

MARYLAND [illegible]
UNIVERSITY [illegible] LIBRARY
COLLEGE PARK, MD.

TOWARD A MORE MODERN STATE

A
Survey of Agricultural Research in Maryland

EIGHTY – THIRD ANNUAL REPORT

BULLETIN A-181

OCTOBER 1973

Volume No. III

COLLEGE PARK, MD.

DO [illegible] CIRCULATE

TOWARD A MORE MODERN STATE

A
Survey of Agricultural Research
in Maryland

EIGHTY-THIRD ANNUAL REPORT
1969-1973

Archives
UPUB
A33.001
V.3

BULLETIN A-181
Vol. No. III of III

UNIVERSITY OF MARYLAND
AGRICULTURAL EXPERIMENT STATION

COLLEGE PARK
MARYLAND
OCT. 1973

6262320

Digitized by the Internet Archive
in 2015

https://archive.org/details/annualreportofma833mary

BOARD OF REGENTS OF THE UNIVERSITY OF MARYLAND

AND

THE MARYLAND STATE BOARD OF AGRICULTURE

1969 – 1973

DR. LOUIS L. KAPLAN, CHAIRMAN, BALTIMORE
RICHARD W. CASE, VICE CHAIRMAN, BALTIMORE
B. HERBERT BROWN, SECRETARY, BALTIMORE
HARRY H. HUTTLE, TREASURER, DENTON
MRS. ALICE H. MORGAN, ASSISTANT SECRETARY, CHEVY CHASE
F. GROVE MILLER, JR., ASSISTANT TREASURER, N.E., MARYLAND
MRS. MICHEAL J. DEEGAN, JR., ROCKVILLE
GEORGE C. FRY, CECILTON
SAMUEL H. HOOVER, D.D.S., TIMONIUM
EDWARD V. HURLEY, BALTIMORE
HUGH A. McMULLEN, CUMBERLAND
L. MERCER SMITH, BALTIMORE
EMERSON C. WALDEN, M.D., COLUMBIA

UNIVERSITY OF MARYLAND
AGRICULTURAL EXPERIMENT STATION
COLLEGE PARK, MD.

TO: The Governor of Maryland
The Board of Regents
and the President, University of Maryland

The Maryland Agricultural Experiment Station research program is dedicated to the advancement of agricultural sciences for the benefit of the citizens of the State. The proper interpretation and application of this knowledge will enhance production of crops, poultry, livestock, and livestock products. Perhaps of equal importance, this knowledge will enable improved utilization, management and conservation of land, water, air and energy resources. Most importantly, much of this new knowledge will contribute to improved quality of life for people whether their residence is rural, suburban or urban.

The major program thrust is to improve efficiency of production of crops, animals and animal products. Such enhancement may be from varieties or species which give higher yields or better nutritive quality, which may be more resistant to diseases or insects, or which result in improvement rather than degradation of land and water resources, or from systems which require less labor or eliminate drudgery and hazards.

Production oriented research is followed by processing or utilization research, and this includes nutritional values for, and acceptability of, new products by people. Thus, agricultural research is not just for farmers or agribusinesses; it is the basis of fulfillment of food and fiber needs for all people. Agricultural sciences are also the basis of management of home gardens, landscaped yards, and recreational areas of parks, forests and golf courses.

Production agriculture has historically been the Station's primary concern. However, in recent years much effort has been focused on waste management, economic policies, marketing systems, nutritional and consumer needs, aquatic biology and pollution abatement.

In recent months supplies and prices of food, agriculture's role in world trade, the balance of payments and the energy requirements for producing and processing of crops have been front page news. Study of the summaries in this report will show a high level of relevancy between our research and current critical needs.

It is with pleasure that I transmit this Eighty-third Report of the Maryland Agricultural Experiment Station established at the University of Maryland in accord with requirements of Acts of Congress, March 2, 1887. Reported here is research for the period July 1, 1969 - June 30, 1973, and a statement of receipts and disbursements for the same period.

Respectfully submitted,

R. L. Green
Acting Director

TABLE OF CONTENTS

VOLUME III

Pages

DEPARTMENT PROJECT REPORTS

Agricultural and Extension Education 1

Agronomy 5

Animal Science 28

Botany 41

Dairy Science 63

Entomology 72

Contribution No. 4871 of the Maryland Agricultural Experiment Station
Ms. Rec'd. 5-73.

PROJECT REPORTS

HORTICULTURE

CROP MANAGEMENT STUDIES WITH VEGETABLE CROPS

Fall Application of Plastic Mulches and Fumigants for Cantaloupes

The use of soil fumigation with polyethylene mulches increases the total and marketable yields and increases the earliness of cantaloupes. Melons grown on mulched plots ripen 10 days to 2 weeks ahead of those not mulched. Fumigation aids in control of soil borne pests and weeds.

The time of application of the fumigant and plastic mulch in the early spring is critical, but delays may result from unfavorable weather condtions, excessive soil moisture or the schedule of the custom applicator. Some time must elapse between application and planting to obtain adequate fumigant activity and to allow for fumigant dissipation to levels safe for the crop. Fall application would avoid many of the problems associated with application in the spring.

Different kinds of plastic mulch and broad-spectrum fumigants were applied to field plots in November. Cantaloupe plants grown in peat pots in a hot bed were transplanted into the plots in May of the following year. Mulch treatments included 1-1/2 mil and 4 mil natural polyethylene, 4 mil ultraviolet resistant polyethylene, 1-1/2 mil black polyethylene, and a control treatment with no mulch. It was expected that natural polyethylene without ultraviolet inhibitors would show deterioration before planting time, but none was observed in two years of trials. Deterioration of the natural polyethylene did take place later in the summer, but by that time the mulch had largely served its intended purpose.

All the mulch treatments were superior to the non-mulched in vine growth, early yields and total yields. The clear or natural polyethylenes showed somewhat larger early yields than the black in the first year of the trial, but not in the second year.

A fertilizer test with fall applied polyethylene mulch showed that a basic application of 800 lb/A of 10-10-10 prior to the mulch application in November resulted in melon yields equal to those with 1,200 or 1,600 lb/A of 10-10-10. An additional 40 or 80 lb/A of nitrogen did not increase yields over the basic rate of 800 lb/A of 10-10-10.

Fall application of plastic mulch and fumigants for cantaloupes appears to be feasible and practical. This may also be very desirable considering possible unfavorable weather and crowded schedules in the spring.

Narrow Rows for Lima Beans

Plantings of lima beans at the Vegetable Research Farm over a 4-year period show that yields from 18-inch rows are considerably larger than those from conventional 36-inch rows. Yield increases were 46, 36, 56, and 64 percent in 1969, 1970, 1971 and 1972, respectively, for an average increase of 1,211 lb/A. In contrast, large variations in plant spacing within the row had little effect on yield.

Yield differences were not significant in any of the years as a result of spacings varying from three to nine inches between plants in the row.

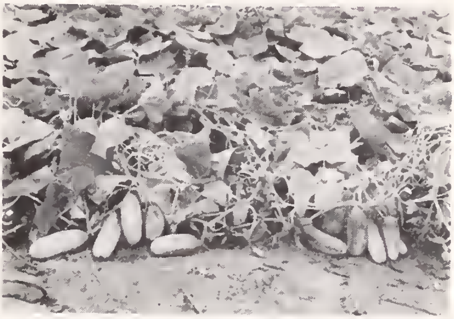
The equipment and cultural methods currently used for growing lima beans in 36-inch rows are suitable for use with 18-inch rows with minor modifications.

Cultivation of narrow row plantings would have to be limited to the very early stages of plant development. With effective herbicides, little cultivation should be needed. Effective spray coverage may be more difficult with closer plantings, especially late in the season. However, excellent pest control has been achieved in these experimental plantings in each of the four years.

There are problems with the use of present harvesting equipment with 18-inch rows. Vine-cutters (such as are used with peas) fail to harvest many pods near the base of the plants, leaving many in the field. Vine-pullers, which sever plants below the soil surface, result in severe damage to plants by tractor wheels. Planting in blocks of three or four narrow rows, with spaces left between blocks for tractor wheels, should provide some of the advantage of narrow rows with present equipment. The new pod-pickers, designed for harvesting narrow-row plantings of snap beans, should also harvest lima beans in narrow rows.

Tape Seeding of Cucumbers for Mechanical Harvest

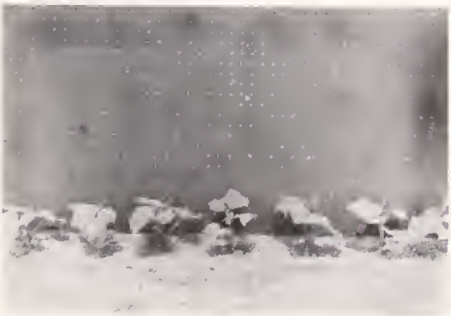
To be profitable, once-over mechanical harvest of vegetable crops requires reasonably uniform maturity of the crop, with a high percentage ready for use at one time. Many factors influence uniform maturity including variety, soil, climatic conditions and cultural practices. Planting methods are very critical with pickling cucumbers. To attain uniform maturity, cucumbers must be properly planted in a well prepared seed bed to give uniform emergence and a high plant population - about 75,000 to 100,000 plants per acre - with plants fairly evenly spaced. The high cost of hybrid seed and of labor for hand thinning require planting to the desired stand.



Uniform maturity of cucumber fruits at time of once-over harvest

Due to the irregular size and shape of seeds, it is not easy to obtain desired stands of cucumber plants. Most planters place from one up to four or five seeds at each site. Multiple seed drops add to the cost of seed, and irregular plant stands contribute to non-uniform maturity.

Seed tape plantings, a new technique which offers the possibility of precise placement of single seeds, was tested with pickling cucumbers at the Vegetable Research Farm at Salisbury. In this technique, cucumber seeds are placed at the desired spacing in water soluble plastic tape by a commercial supplier. The planter then inserts the tape into the prepared seed bed at the desired depth and row spacing from reels of tape mounted on the planting unit.



Uniform singly-spaced plants from tape seeding

Some results of the test are illustrated. Use of tape seeding resulted in highly uniform development of young cucumber plants, accurately spaced in the row without hand thinning and improved the uniformity of fruit development at the time of once-over harvest.

Advantages of the tape seeding method include the precise placement of seeds at the depth and spacing desired - even with seeds that are very irregular in size and shape. Single placement of seed is easily and accurately accomplished, but clump seeding may also be done if desired. Disadvantages of the technique are a slight delay in emergence of seedlings and the extra cost of the seed tape to the grower.

USE OF DEGREE DAYS TO SCHEDULE PLANTINGS OF PICKLING CUCUMBERS FOR ONCE–OVER MACHINE HARVEST

Production of pickling cucumbers for once-over machine harvest requires carefully controlled planting schedules to provide cucumbers of desired maturity, maximum returns and efficient use of harvesting machines. The per acre value of a given planting typically rises to a peak over several days, then decreases rapidly. The time during which the crop may be harvested to obtain highest returns is very short. Degree day or heat unit systems are widely used in scheduling plantings of peas and sweet corn, but results with pickling cucumbers have been variable.

Data from research plantings over several years and from a series of 25 commercial plantings in 1972 have provided information for a more critical evaluation of such a system with several gynoecious hybrids and standard monoecious lines. A 45 deg. F base temperature gave better results than the 50 deg. temperature often used, and 41 deg. gave results essentially equal to 45 deg. Disregarding maximum temperatures above 86 deg. improved the relationship between degree day accumulations and growth and maturation of cucumbers at all base temperatures used. Apparently, the rate of growth of cucumbers does not continue to increase above 86 deg. A 45 deg. F base temperature, with maximum temperatures above 86 deg. F disregarded (i.e., considered to be equal to 86 deg.), resulted in 80% of plantings being ready to harvest within 1-1/2 days of the time indicated by degree day accumulations.

GROWING FALL BROCCOLI FOR FREEZING

Growing broccoli for freezing has not been profitable in this area due to low yields, large labor requirement for transplanting and harvesting and excessive insect damage, especially by cabbage worms. Several aspects of cultural systems have been studied to learn how to improve production and reduce costs. Some conclusions from the study are summarized below.

Yields from 18-inch rows are about 50 percent larger than those from conventional 36-inch rows, but average head size is reduced. Yields increase with closer plant spacings within either 18 or 36-inch rows, with closer spacings also resulting in somewhat smaller heads. Spacings of 9 to 15 inches between plants are suggested.

Direct seeding of broccoli will produce adequate stands at lower costs than transplanting. Successful seeding during the hot summer months (usually during July and early August) requires accurate planter placement of seed having good vigor and high viability, planting seed into moist soil, use of effective and safe herbicides and light irrigation at frequent intervals during the first week or two following emergence. Best results are obtained by planting into moist soil, which results in emergence in three to five days, with light irrigations applied after emergence as needed. Irrigating before emergence should be avoided due to crusting and packing of soil. Direct seeding speeds up maturity of broccoli about 10 days as compared to transplanted broccoli seeded at the same time.

A Stanhay planter which uses punched rubber belts for metering seed has given good success in planting broccoli, requiring a minimum of hand thinning.

Several new F_1 hybrid varieties show excellent vigor and fairly concentrated maturation of heads. The vigor and rapid growth of the hybrids improves success from direct seeding and concentrated heading reduces the number of harvests required and therefore the cost of harvesting. For mechanical harvest it is desirable that 80 percent or more of the heads should be ready to cut at one time. No variety available at this time has such concentration, however. The table below shows results with 4 F_1 hybrids direct seeded at different plant populations in 1971.

Project No. Q-77

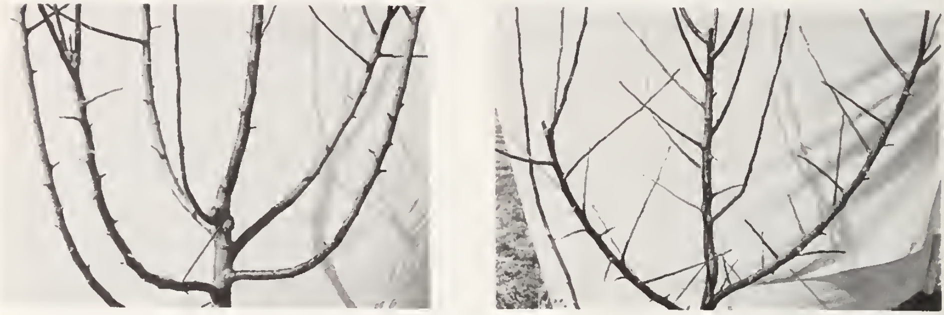
CULTURAL STUDY WITH BROCCOLI – 1971
DEPARTMENT OF HORTICULTURE, UNIVERSITY OF MARYLAND
VEGETABLE RESEARCH FARM, SALISBURY, MARYLAND

Row Width, inches	In-Row Spacing, inches	Variety	Total Yield Center Heads, Lbs/A	Average Head Wt., Lbs.	%Heads with Hollow Stem	Percent of Center Heads Cut At:	
						Single Largest Harvest	Two Largest Harvests
18	12	Green Duke	6901	0.28	2	50	78
		Bravo	7375	0.28	11	65	85
		Crusader	7560	0.34	47	49	76
		Gem	7066	0.27	33	47	83
		Average	7225	0.29		53	80
18	Not Thinned	Green Duke	9126	0.24	2	44	82
		Bravo	7766	0.22	11	54	80
		Crusader	7643	0.27	41	54	79
		Gem	6880	0.19	17	49	79
		Average	7853	0.23		50	80
36	12	Green Duke	4676	0.42	30	55	79
		Bravo	4099	0.32	25	54	75
		Crusader	4676	0.44	64	54	83
		Gem	4429	0.33	46	45	89
		Average	4470	0.38		52	82
36	Not Thinned	Green Duke	5346	0.34	17	53	79
		Bravo	4862	0.25	16	48	72
		Crusader	5222	0.33	51	58	75
		Gem	5201	0.26	26	35	68
		Average	5157	0.30		48	78

Broccoli was direct-seeded with a Stanhay planter July 13, 1971. Stanhay belts were punched to drop 3 single seeds, 1 inch apart, at 12-inch intervals. Some plots were thinned after emergence to 1 plant per foot of row and others were left unthinned.

TREE DESIGN FOR HIGH DENSITY APPLE ORCHARD PROMISING

Initial work on this project has involved development of a modified central leader tree worked to a moderate size-controlling rootstock. Inherent in this system is primary spreading of scaffold branches to produce a wide, strong crotch angle, with subsequent secondary spreading of the branch to encourage early fruiting and to achieve maximum exposure to sunlight throughout the tree. Sustained training of some 400 experimental trees indicates that the system is sound, can be done with standardized pruning cuts, and that early fruiting is likely to provide ample return to pay for increased attention to training in early years. Before and after pruning, the first and third years are illustrated in the accompanying photos.



Lateral shoot development on two-year wood from delayed heading of terminal shoot. Headed in March (left); in May (right).

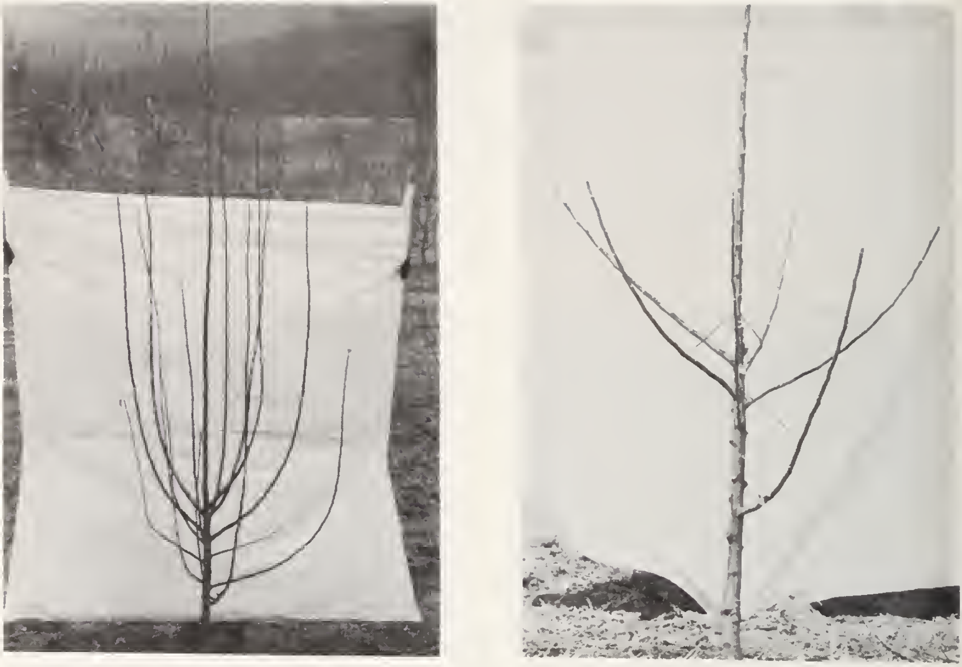
Moderate heading-back of terminal shoots on scaffold branches, as well as the central leader, is done to stiffen scaffold structure. Dormant pruning has long been known to be less dwarfing than non-dormant pruning. It was found in this work that delaying the heading-back cut until growth began in spring resulted in markedly greater development of short fruiting wood on two-year old scaffold branches (see photo). Considering basic scaffold branches only, heading of the terminal shoot was done on different trees in the dormant, delayed dormant, full bloom and 13 days after full bloom. The later the heading was done in this period, the shorter the resulting terminal shoot, the more the laterals on two-year wood and the shorter these laterals were. This response is illustrated by the following data:

Time of heading cut*	Terminal shoot length (cm)	Average no. of laterals per 10 cm of 2-yr wood	Average length of laterals on 2-yr wood (cm)
Dormant	85	1.4	29
Delayed dormant	77	1.7	24
Full bloom	58	1.9	20
FB + 13 days	55	2.1	17

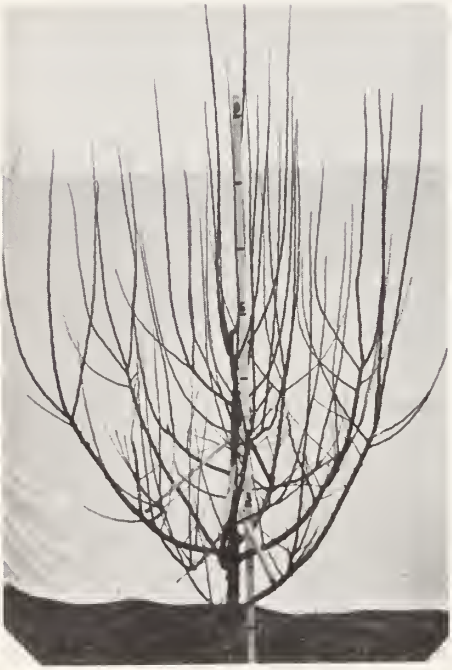
*Cuts made in spring, 1972; measurements made 12/72. Trees Red Delicious/MM 106, planted spring, 1970.

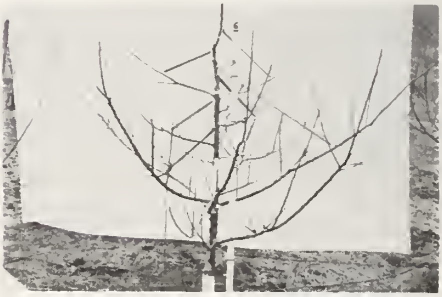
The modified central leader tree on a size-controlling rootstock is suitable for medium density (150 to 300 trees/acre) plantings in Maryland. Some varieties will fruit too early on a rootstock such as MM 106, but with delayed heading of terminals no variety need fruit too late. The key to this system is spreading of scaffold limbs and timely use of the pruning shear. Orchards trained to this system can be contained in medium density, can be handled with standard tree machinery and will afford high production per acre of quality fruit within reach.

Project No. L-74-D



First Year (Left & Right)





The modified central leader tree before and after pruning the first year (right) and the third year (left) in the orchard

MINERAL NUTRITION OF THE APPLE WITH SPECIAL REFERENCE TO CALCIUM, MANGANESE, AND ZINC

Apple Tree Bud Union – Bridge or Block?

Access of plant nutrients across the union between rootstock and scion variety of the apple tree is little understood. Graft incompatibilities have been known for centuries, but in compatible unions the transfer of nutrients has been assumed to be free passage.

In sand culture studies on internal bark necrosis (IBN) of the Delicious apple, the full dwarfing Malling 9 rootstock was used with solution culture providing precise adjustments of all plant nutrients. IBN was quickly produced with 80 ppm of manganese in the solution. While typical and severe necrotic symptoms developed on the Delicious bark, none were exhibited on the M 9 bark below the bud union (see photo). Analysis of bark and wood tissues showed that stock manganese was somewhat higher than that in Delicious scion bark. Calcium in the stock bark was three times higher than that in the scion. It has been demonstrated in previous work that calcium in the soil prevents toxic absorption of manganese. In these studies, it was found that calcium accumulates in the stock, and for some reason does not move freely into the scion.

The results suggest that the graft or bud union in the apple does not provide free passage for all nutrients, and that stock selection can have a considerable influence on nutritional disorders such as IBN. Further studies on this problem are in progress.

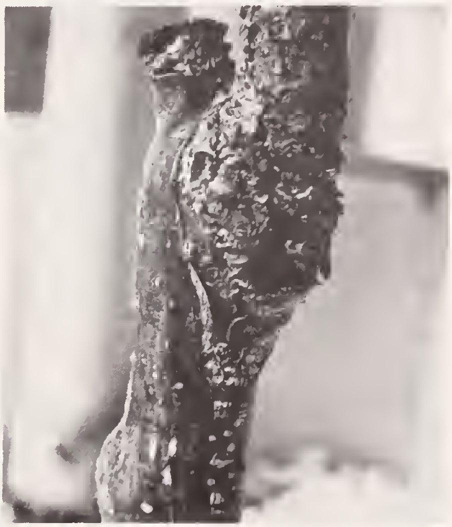
Manganese Toxicity in Apple Related to Other Plant Nutrients

In solution culture studies on internal bark necrosis (IBN) of the Delicious apple, symptoms were produced with 80 ppm of manganese in the nutrient solution, and then nutrients were manipulated in solutions to study correction of the disorder. Reduction of manganese from toxic levels resulted in recovery and normal growth. Increasing calcium in solutions otherwise still high in manganese also provided correction, but increasing boron did not.

High manganese in the culture solution was shown to depress calcium accumulation in the bark of the tree, but in this interaction study it was clearly shown that this phenomenon was dependent on the supply of potassium. In low potassium solutions, manganese had little effect on calcium absorption. In high potassium solution, manganese had a pronounced influence on calcium accumulation.

These results indicate that IBN is a complex nutritional disorder. Toxic accumulation of manganese has long been recognized as a primary cause. However, it appears that the relationship between manganese and calcium is dependent on yet a third element - potassium.

Project No. L-79-H (Revised)



Bud union of young Delicious apple tree showing necrotic bark on Delicious scion and smooth bark on Malling 9 rootstock

ETHEPHON, A PROMISING CANDIDATE FOR SPRAY–THINNING OF THE PEACH

Ethylene gas has long been known to cause abscission of plant parts, especially leaves and fruits. It has recently been discovered that the chemical ethephon ((2-chloroethyl) phosphonic acid) has the unique property of causing ethylene production in the plant when applied in aqueous solution. Efforts in peach thinning research have been focused since 1968 on the potential of this compound for spray-thinning of this crop.

Extensive orchard experiments have been conducted at College Park and in Western Maryland on the 'Redskin' and 'Redhaven' cultivars. Spray treatments have been applied from three weeks ahead of blossoming to six weeks after blossoming at concentrations up to 1200 ppm. The best thinning has been achieved during the blossoming period and, while good thinning has resulted from sprays applied well after bloom, unaccepatable defoliation has accompanied late thinning.

Current research is being conducted to determine factors associated with greater or less defoliation, and with consistent year-to-year thinning with applications close to blossoming. Ethephon is a promising thinner for peach, but as yet is not cleared for use in the orchard for this purpose.

Project No. L-74-B

NEW SWEET POTATO VARIETIES

Two new sweet potato varieties have been released by the Department of Horticulture, Maryland Agriculture Experiment Station. Redmar, released in 1971, was tested as Md. 2416 in replicated yield trials for 3 years and averaged 626 bu/A total marketable yield as compared to 422 and 500 bu/A for Nemagold and Centennial, respectively.

Redmar has an attractive red skin which is fairly resistant to abrasion. The variety produces large numbers of roots per hill of uniform size and shape. The flesh is deep orange and very moist when baked. Redmar requires a long season for the roots to reach U.S. No. 1 size, and therefore should be considered a mid to late-season variety. The storage characteristics are similar to Nemagold, with pithiness developing after 3-4 months storage. Redmar produces sturdy, rather short sprouts similar to Centennial.

Canning tests have shown Redmar to produce a product of excellent color. Although canned samples of Redmar are no firmer than Nemagold, they may be superior to Nemagold in wholeness.

Storage tests indicate that Redmar may be less susceptible to surface rot than Nemagold, but more subject to soft rots. Field tests of two years with cooperating growers have not shown unusal disease or insect problems. Inoculation tests have shown susceptibility to Fusarium wilt and to pythium.

Nematode trials indicate resistance to the root knot nematode.

The pedigree of Redmar is (((K1840) x B6313) x Shoreland) x (Virginian x K1846) Goldmar, released in 1972, is a skin-color mutation of Redmar. This variety is essentially identical to Redmar except for its golden skin.

ProjecQ-81-F

PRODUCTION OF SWEET POTATOES FROM ROOT PIECES

Sweet potatoes are usually produced from sprouts or vine cuttings. Because of the high cost and extensive labor requirements of both methods, an alternative procedure is desirable. One such method is production from small whole roots or root pieces. This is commonly practiced with Irish potatoes. The root-piece method is not new, although previous attempts have been unsuccessful.

More recently, however, researchers have indicated that root piece culture might be practical with the proper variety. Characteristics which make a variety adaptable to root piece culture include, 1) The root piece, which is planted, does not enlarge and preferably decomposes, 2) New potatoes must be produced on the sprout arising from the original root piece.

The varieties 'Redmar' and 'Goldmar', along with several breeding selections, seem to possess the desirable characters needed for root piece culture. In limited trials, conducted over two seasons at the Vegetable Research Farm, crops of sweet potatoes, comparable in yield and quality to those produced from sprouts, were produced from root-pieces. The potatoes are not produced in compact hills as are sprout-grown potatoes, but tend to spread out 12-16 inches.

Hill of 'Redmar' sweet potatoes grown from a root-piece

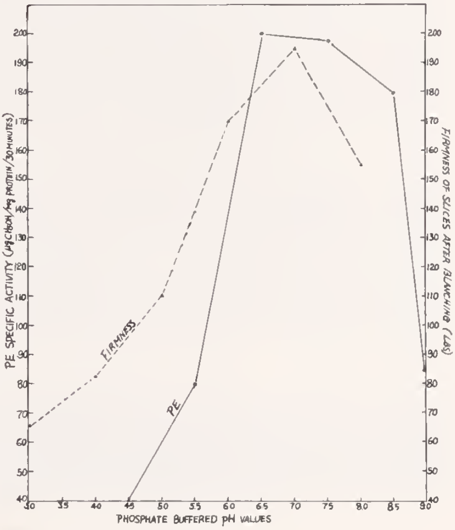
Growing sweet potatoes from root-pieces eliminates several steps required for production from sprouts. Bedding of roots and pulling of sprouts would no longer be required. Also, much of the labor required for transplanting could be eliminated. Cutting and planting root pieces could be mechanized.

At present, the production of sweet potatoes from root pieces is not a recommended practice. Certain diseases may present special problems not associated with the production of sprouts. Environmental conditions which may affect production from root pieces have not been studied.

Project No. Q-77

UTILIZES ENZYMES TO MODIFY TEXTURE OF APPLE SLICES

Earlier work has determined that calcium (Ca) salts are satisfactory compounds to firm soft fruit tissue. They have been used to firm apple slices, peaches, pears, tomatoes and other products. Current research shows the possibility of using natural enzyme activity to modify the texture of apple fruit. One enzyme that opens sites for Ca ions to firm fruit and vegetables is pectinesterase (PE). Activity of this enzyme is extremely slow at pH 3.3, however, at pH 6.0 it is much higher and can increase the effectiveness of Ca firming. Figure 1 shows a typical relationship between PE enzyme activity and firmness of fruit when Ca is added to apple slices over a wide pH range. It follows that adjustment of pH of apple tissue will change the activity of the PE enzyme, and that slices will be firmest at pH's between 6.0 and 6.5. Changing pH's back to the normal ranges



for apples (pH 3.3), showed that this firming was maintained once it was accomplished. Processors of fruits and vegetables should be able to adjust the pH of their products thereby triggering certain enzymes systems. This will modify texture and then later return the product to normal pH's for favorable color and flavor characteristics.

Project No. Q-58-T

SEASONAL UTILIZATION OF NUTRIENT ELEMENTS BY THE SWEET POTATO

Time of application and availability of plant nutrients in relation to utilization by the plant is especially important with crops having a long growing season. This is particularly true with the sweet potato which may have a growing season of four months or more. It is generally grown in light sandy soils, quite subject to leaching of nutrient elements.

Analysis of a crop planted on May 24 and harvested October 21 showed that, with the exception of manganese, from 42 to 74 percent of the total accumulation of nutrient elements by the plant takes place after the first of August, during the development of the fleshy roots or potatoes. Total uptake of nitrogen, potassium and magnesium corresponded in amount to that supplied in the fertilization program. This emphasizes the necessity of maintaining adequate levels of these readily leached nutrients throughout the period of crop growth. On the other hand, the amount of phosphorus supplied in the fertilizer was several times that taken up by the plant. Soil analysis of the Norfolk sandy loams used for sweet potato production typically show "low" to "medium" values for potassium and magnesium and "very high" values for phosphorus. The data emphasize the over-use of phosphorus in the fertilization of sweet potatoes on these soils.

Project No. Q-77

CONTROL OF GROWTH AND FLOWERING OF THE CARNATION (DIANTHUS CARYOPHYLLUS L.) BY TEMPERATURE, PHOTOPERIOD, AND CHEMICAL GROWTH REGULATORS FOR SINGLE–CROP PRODUCTION IN THE GREENHOUSE

Carnations have traditionally been produced in greenhouses as a continuously flowering crop with replanting done each year in early summer. The demand for carnation flowers, however, fluctuates both as to quantity and as to type or color. There is a need, therfore, for production techniques to produce a single crop of a given variety in a given, short period of time. Recent research at Maryland, and at many other stations, has brought to light methods for control of carnation growth and flowering. These methods can be adapted to benefit a single-crop system of carnation cut-flower production.

It has been shown that long days and cool temperatures promote floral initiation in carnation. Work prior to 1969 at this station established some of the benefits from the use of artificial light to be earlier flowering, more flowers and a concentration of flowering into a shorter period. Another effect was an increase in the internode length of stems lighted during the later phases of growth. The best source of light was the ordinary incandescent filament lamp, and an intensity of two ft. c. of light was adequate. Carnation shoots were sufficiently developed to respond to lighting at five to seven weeks after rooting or two to four weeks after pinching, depending upon growing conditions. Treatments begun as late as seven weeks after pinching were capable of hastening flower formation.

The effectiveness of lighting was increased by lengthening the duration of the lighting period each night up to the point of all night lighting. However, for practical purposes, maximum response in early flowering was obtained by division of the natural dark period by eight hours of low intensity incandescent light. Based upon these results, a typical single-crop carnation program to produce flowers for mid-December would consist of:

1) Take cuttings for rooting on July 1.
2) Plant rooted cuttings in greenhouse on July 25.
3) Remove terminals to induce branching on August 15.
4) Provide incandescent lighting of two ft. c. or more from 8 p.m. to 4 a.m. from September 1 to September 21.
5) Maintain greenhouse night temperatures as cool as possible during September and 55 deg. F through the fall months as greenhouse temperature becomes controllable by heating.

Further work has shown certain benefits in control of flowering in the pretreatment of young plants before they are planted in the greenhouse for flower production. Cuttings rooted under the influence of long days flowered earlier then those rooted under short days. Young branched plants have also been induced to flower earlier by subjection to colder temperatures of 40-55 deg. F plus supplemental lighting.

Current research involves the screening and use of new growth regulating chemicals, in addition to those chemicals currently available, and the integration of their effects into a single-crop flowering program. From the presently known effects of available chemicals, these benefits could include the production of more cuttings of uniform response, faster rooting, increased branching, growth control, promotion of flowering, larger flowers and stronger stems.

Project No. I-79-N Hatch (Revised July 1972)

CONTAINER PRODUCTION OF WOODY ORNAMENTALS

During the past ten years, drastic changes have taken place in the production of woody ornamental plants. In addition to growing plants in the fields, many nurseries are now growing ornamentals in containers. This change in cultural practices has introduced new problems of fertilizing, growing media and winter protection.

Fertilizing

Nurseryman growing ornamental plants in fields can utilize commercially available fertilizers with reliable success. Because artificial media is generally used for growing ornamentals in containers, typical agricultural fertilizers are not designed for such use. To overcome this difficulty, slow-release and liquid fertilizers were evaluated in this research.

Rooted cuttings of Japanese Hollies. Foster Hollies, Cherry Laurel, and Waukegan Junipers were grown in six or eight inch containers. An artificial growing media was prepared of three parts peat and two parts sand with six lbs. of dolomite limestone and two oz. of fritted trace elements added to each cubic yard of mix.

One Year Production Studies

The following fertilizers or combinations of fertilizers were evaluated on plants growing in six inch containers for a 12 month period.

1. Osmocote 18-9-9 and MagAmp 7-40-6 in 12 different combinations.
2. Osmocote 18-6-12 and ureaformaldehyde 38-0-0 in 12 different combinations.
3. Agriform 14-4-6, 12 gr. container tablets at two different rates and at three different times of application.
4. Liquid fertilizer 25-10-10 applied at 150-200 ppm of N at each irrigation.

The results indicated that plants fertilized with Osmocote 18-6-12 at eight to 10 oz. per bushel or plants fertilized at six week intervals with one, 12 gr. 14-4-6 container tablet grew as well as plants fertilized at each irrigation with 150 to 200 ppm of N from 25-10-10.

Two Year Production Study

The possibility of putting all of the nutrient needs of the plant in the container for two years was investigated. Rooted cuttings were planted in eight inch containers with one or combinations of the following slow-release fertilizers:

1. Osmocote 18-6-12
2. Easy-Grow Packet 19-5-17
3. Agriform 14-4-6, 12 gr. container tablets, one every six weeks.
4. Agriform 20-10-5, 21 gr. planting tablet.
5. Liquid fertilizer 25-10-10 applied at 150 to 200 ppm of N at each irrigation.

The results indicated that after two years of growth the plants growing in fertilizer combinations of Osmocote and either Easy-Grow Packets or Agriform 20-10-5 Planting Tablet, produced as much growth as plants fertilized at each irrigation with 25-10-10, or in the early spring with Osmocote 18-6-12 or every six weeks with Agriform 14-4-6, 12 gr. Container Tablet. However, at the end of the second growing season, the plants that had all of the necessary slow-release plant nutrients placed in the container at the beginning of the experiment were of poorer quality than those plants receiving the liquid fertilizer, Agriform Tablets or the Osmocote.

Fertilizer Placement

Because uniform soil incorporation is difficult to accomplish under certain nursery condtions, alternate methods of using Osmocote 18-6-12 were investigated by comparing soil incorporation to top-dressing and to side-dressing.

The results indicated plants that were either top-dressed or side-dressed with two teaspoons (6 oz./bu.) of Osmocote, grew as well as plants receiving eight oz./bu. incorporated into the soil prior to planting. Therefore, it is possible to grow the same number of quality plants with 25 percent less Osmocote by either top-dressing or by side-dressing each plant immediately after planting.

Growing Media

The rising cost of imported peat is forcing many of the nurseries to seek other sources of organic materials for their growing media. In these studies rooted cuttings of Japanese Hollies and Cherry Laurel were planted in six inch containers. The growing media consisted of various combinations of pine bark, oak bark, native peat, sphagnum peat, chopped leaves, sand and commercially available mixes. All plants were fertilized with nine oz. of Osmocote 18-6-12 per bushel uniformly incorporated prior to planting.

The results indicated that as the percentage of bark increased, plant growth decreased. Ground leaves did not serve as a good substitute for peat and native peats were inferior to imported peats.

Winter Protection

Roots of woody ornamental plants are not as cold hardy as their tops. To over-winter many species of container grown ornamental plants, nurserymen move the plants each fall into partially heated greenhouses. In addition to the added labor, the greenhouses are expensive and require periodic inspections during the winter months.

To reduce the need for added labor in the fall and spring and the expense of greenhouses, several structure-less overwinter techniques were developed and tested.

Japanese Hollies and Cherry Laurel growing in six inch containers were thoroughly watered in mid-November. The plants were laid on their sides to protect their branches and packed container to reduce the total surface area to be covered. The plants were then given the following winter protection:

1. A single layer of clear or white polyethylene.
2. A quilt made of clear or white polyethylene, four inches of loose straw, cornstalks, or corn-stalks and straw, and another layer of clear or white polyethylene.
3. A single or double layer of Air-Cap (a light weight plastic packaging material) used with or without clear or white polyethylene.
4. A single or double layer of Microfoam (a flexible styrofoam-like packaging material) with either a single or double layer of clear polyethylene.
5. No winter protection.

Temperatures were recorded under each treatment throughout the study. In mid-April the effectiveness of each treatment was evaluated by examining the roots and tops of each plant.

The results indicate that both Japanese Holly and Cherry Laurel can successfully be overwintered by covering them with a single layer of one-quarter inch Microfoam and a layer of clear polyethylene. The plastic straw-plastic quilt was also effective in protecting plants, however, not all plants under the quilt were uniformly protected. In the spring the straw was also difficult to remove and discard. Air-Cap proved to be unacceptable. The plants that received no protection, as well as those that were only covered with a single layer of plastic, were either completely killed or severely damaged.

The use of Microfoam in commerical container nurseries appears to be promising. It is light weight, readily available, has a high insulating value, gives uniform coverage, and appears to be reusable if it is properly stored.

Project No. I-79-O

MANAGEMENT–CULTURAL STUDIES ON WOODY ORNAMENTAL PLANTS

Herbicides

Herbicides have been studied as to their weed control abilities and their effectiveness with many crops. Nursery crops, the woody ornamentals, present special problems and little is known of the tolerance of such plants to these herbicides.

During the past four years, 16 species of woody ornamental plants, including conifers, broad-leafed evergreens and deciduous plants have been used. These have been planted in a nursery situation and different herbicides or combinations of herbicides were used. Records were made not only of their effectiveness for weed control but special attention was given to evaluating these materials as to their influence on plant growth and possible plant injury. From studies during 1969, 1970 and 1971 it was found that the following herbicides: alachlor; chlorbromuron; diuron; linuron; simazine and trifluralin were generally effective in weed control, and with no serious plant damage. In only two cases was a slight chlorosis observed, as had been noted in previous studies, on reason some blanched frozen and canned corn products are not as flavorful as desired. Results of this research indicate that maturity of the sweet corn at picking, and types of packaging materials used in canning and freezing may have an important influence on the retention of these aroma compounds.

Project No. Q-81-G

MEASURING PECTINESTERASE ACTIVITY

Up to now it has been difficult to accurately measure pectinesterase activity in apple fruit and other fruits and vegetables. Enzyme activity has been determined by a simple pH titration procedure at pH 7.0. Interest in this enzyme centers on the fact that it is involved in the textural changes of most fruits and vegetables. Unfortunately, the pH of most fruit and vegetable tissues is more acid than pH 7.0, thus, for example, enzyme activity at the natural pH of apple tissue, around pH 3.3, is almost impossible to measure by the pH titration procedure.

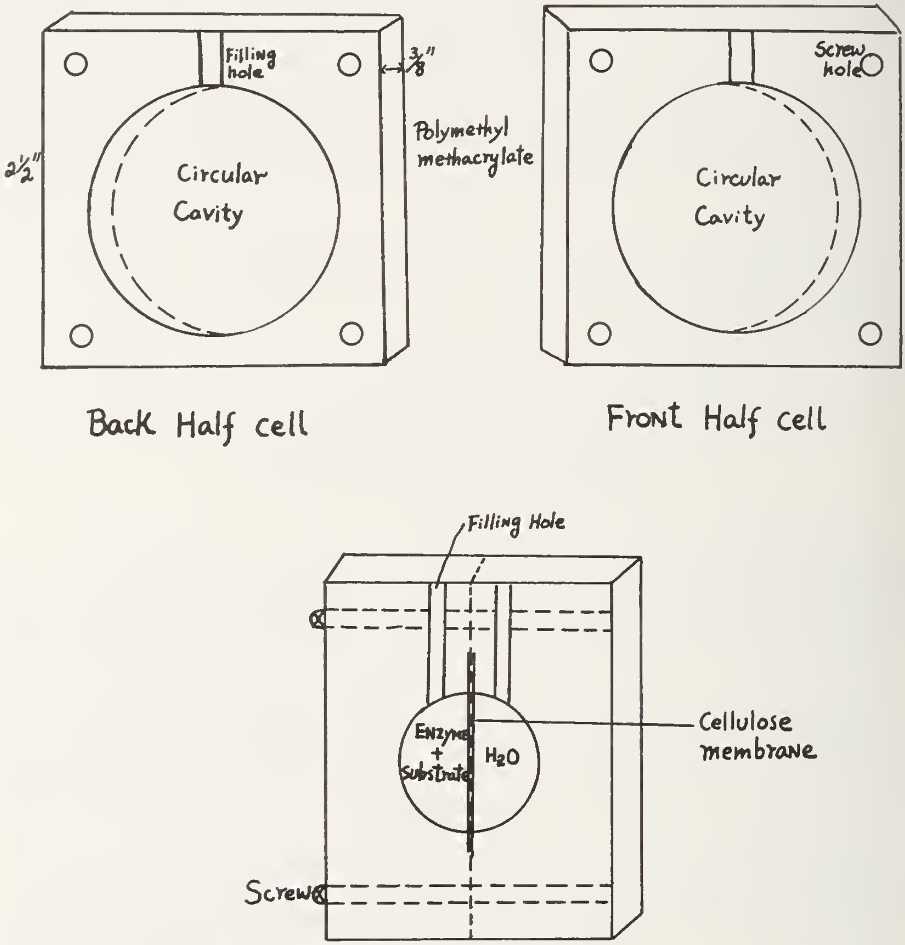


Figure 1. Dialysis cell for pectinesterase analysis

Recently, a new method has been developed to measure pectinesterase at any prescribed pH level by the use of a dialysis cell and a gas liquid chromatograph.

Basically, this pH independent procedure can be used on all types of plant tissues. The enzyme bearing tissue is extracted in a solvent such as acetone, placed in a dialysis cell, a plastic block which has two halves. These two halves contain a cell which is separated by a Visking membrane, regenerated cellulose. The tissue in a solution of high methoxyl pectin is placed on one side of the membrane, and distilled water is placed on the other side. The whole cell is then agitated in a temperature control oven. Reaction of the enzyme of this tissue with the high methoxyl pectin forms methyl alcohol, the end product of this enzyme activity. The methyl alcohol moves through the Visking membrane into equillibrium.

A sample from the distilled water side of the dialysis cell can be injected into a gas chromatograph. The gas chromatograph which is equipped with a flame ionization detector quickly determines methanol concentration, and in turn pectinesterase activity in the tissue sample. This procedure is a simple yet very precise way of determining pectinesterase activity in fruits and vegetables over a wide range of pH's.

Project No. Q-58-T

GREENHOUSE FLOWERING POT–PLANT CROPS

Azalea, Begonia, Chrysanthemum, Cyclamen,
Gardenia, Hydrangea, Lily, and Poinsettia

Flowering potted plants collectively constitutes the most important item produced in Maryland greenhouses and those listed, constituting the major species grown, have all been worked with in the experimental program. The poinsettia program has had the most emphasis. An extensive variety evaluation program has been continued and cultural requirements and scheduling procedures for new varieties have been determined. Procedures for more efficient cutting production as well as propagation have been worked out and rooting under mist in the pots in which the crop will be sold is now in general use throughout the country. A study to determine relative resistance of the many poinsettia varieties to white fly infestation has established that wide degrees of resistance and susceptibility to white fly exist, and has led to a study of integrated control of this pest by cultural and chemical means.

Newly introduced varieties of *Begonia elatior* have received much interest by flower growers but many problems have been encountered including efficient reproduction, flowering control and disease problems. A new research program with this crop is underway. Propagation by leaf cuttings is being studied to test the effects of cytokinins, auxins and ethylene producing compounds on rooting and adventitious bud formation and the other problems will be studied.

Many of these crops are being used in a series of similar studies of such things as 1) The use of "slow release" fertilizers 2) Artificial soil mixtures or 3) The chemical control of growth of such phases of production as obtaining cuttings, rooting, branching, chemical pruning, height control, delay or promotion of flower initiation, and flower modification.

Extensive work with all crops has been concerned with height control; usually reduction of plant height. Each crop responds to different growth retardants and application techniques and dosages have been established for many:

Poinsettia – Soil or application of ancymidol, chlormequat or SADH.
Azalea – Foliar application of ancymidol, chlormequat or SADH.
Chrysanthemum – Foliar application of SADH and soil or foliar application of ancymidol.

Hydrangea – Foliar application of ancymidol or SADH.
Gardenia – Foliar application of chlormequat or SADH (or CCDP a chemical not yet available for commercial uses).
Lily – Soil application of ancymidol.

Promotion of flower formation accompanies treatment of azaleas and gardenias with these chemicals. Benefits in root formation and increased branching have been found in a number of crops from the use of ethephon. Many other compounds (ethylene producing, anti-auxins, and cytokins) have been tried with some valuable uses being apparent but the chemicals are not yet available for commerical use.

The modification of the flowers of many plants by chemical treatment has offered a new field for research. Gibberellin can be useful in promoting development of flowers in cyclamen, kalanchoe, hydrangea, and azalea. The resulting flowers are not only earlier, but usually larger. Other experimental chemicals have shown promotive effects. A synthetic cytokinin [adenine, N-benzyl-9-(tetrahydro-2H-pyran-2-yl)] has increased size and pigmentation and CCDP [sodium 1-(p-chlorophenyl)-1,2-dihydro-4,6-dimethyl-2oxonicotinate] has increased size and introduced rugose or crinkled growth patterns, but has not interfered with pigmentation, and in chrysanthemum causes the formation of tubular or quilled petals.

Project No. I-74-A

TO PRUNE OR NOT TO PRUNE?

Pruning of peach trees is considered an essential practice to control tree size and to produce quality fruit. With increasing labor costs, the advent of higher-colored varieties and more efficient pest control, it was thought advisable to question the essentiality of this time-honored practice.

A block of 'Redskin' peaches planted at the Plant Research Farm in 1959 was pruned for the first two years, then half of the trees were left unpruned until after the 1969 crop. The 1962 crop was a failure due to severe drought. For the remaining 7 years, the unpruned trees produced an average of 248 lbs. of fruit per tree and the pruned trees 224 lbs.

Fruit thinning was required each year with an effort made to obtain comparable thinning on pruned and unpruned trees. Fruit size from the unpruned trees was slightly smaller than from the pruned trees, but not more than could be reasonably attributed to the difference in yield per tree. There was no observable difference in quality of the fruit or in the control of pests.

The unpruned trees were not taller than the pruned trees. The unpruned trees did become quite dense and developed small dead wood in the centers. The use of ladders for picking was no greater in the unpruned trees, and harvesting was no more difficult.

After the 1969 crop all trees were pruned. The hitherto unpruned trees required considerably more pruning in order to remove the brushy growth in the tree centers. In the following two seasons the yield of these trees was lower, but by 1972 was equal to the trees that had been pruned throughout the years. The unpruned trees showed somewhat more limb breakage from crop load than the pruned trees, but only two of the 32 unpruned trees were lost from breakage.

It would seem that pruning of 'Redskin' peaches can be omitted for a number of years without serious deleterious effect on fruit yield or quality and without increasing the difficulty of harvest. This project was terminated December, 1972.

Project No. L-74

WASTE DISPOSAL AND UTILIZATION

Using Waste Formed in Vegetable and Cheese Production

A process for utilizing tomato cannery waste was developed where press-cake containing 2/3 of total solids, ten percent protein is usable as cattle feed, and 1/3 of the total solids is precipitated as a 60 percent Tomato Protein Concentrate. This concentrate can be extracted with acetone to form an 85 percent protein isolate, and a tomato flavor and pigment residue may be obtained during the acetone recovery. Significant phytotoxic effects are limited to ripe tomato fruit components. When properly processed by HTST pastuerization, cheese whey can be used up to 50 percent in place of milk for the manufacture of sherbert and ice cream, and mixed with tomato or fruit juices as a "breakfast" drink. This project was completed in 1970.

Biodegradability of Polyamides

A major waste disposal problem is the accumulation of materials that are not biodegradable. Among these are polyamides, such as nylon, which differ from other plastic polymers used for packaging in that they contain nitrogen, which, if available, would be a plant food. A method was developed for measuring biodegradability of polyamides using a high carbon-low nitrogen soil as the medium. A micro analytical-count technique and a respirometric technique were developed. The latter was selected because results could be obtained within a shorter time and the procedure was simpler. Using this method it was found that nylon 66 is not biodegradable, the monomer salt is totally degradable, while polymers up to molecular weight of 500 were biodegradable at slower rates.

The soluble nylon salts were found to improve soil condition in addition to providing a nitrogen source. Work is proceeding to determine the specific microorganisms involved, with the hope of finding a soil microorganism specifically adapted to degradation of polyamides.

Project No. Q-85-A

AUTOMATION OF TRANSPORTATION AND PROCESSING OF TOMATOES AND TOMATO PRODUCTS

Further field tests with the Clemson Harvester have demonstrated its value for mechanical harvesting of Eastern grown tomatoes over similar equipment used in the West, without the expensive manual sorting in the field.

Bulk bins, 42 x 36 inches, 30 inches high, were used successfully to haul mechanically harvested tomatoes from field to processing plant without a water cushion.

Further tests with the field gravity sorter demonstrated that while partial color sorting is also accomplished, this device is essentially a density, not a color sorter. It is, therefore, more useful for sorting tomatoes for different purposes (e.g. whole peeled vs. puree) rather than removal of green tomatoes.

Maximum utilization of one-time mechanically harvested tomatoes was increased from 70 to 90 percent by manually sorting out mature green and color culls, storing for about five days at ambient temperatures, and blending with current ripe fruit.

Even this procedure need not be used with some of the newer high-color varieties. With tomatoes harvested at the stage where two-thirds or more of the fruits are red-ripe (grade A or B), a sufficient quantity of immature green tomatoes can be removed mechanically by size grading so that the remaining fruit will produce grade A canned tomatoes or tomato juice if sorted for rot in the plant. For tomato juice up to ten percent green tomatoes can be tolerated without downgrading color or flavor.

Project No. Q-77-D

DEVELOPMENT OF NEW PRODUCTS AND IMPROVED PROCESSING METHODS

Synthetic Ginger

By step-wise regression analysis of gas chromatographic data, four peaks were found to predict 85 percent of the flavor intensity of ginger. Eight additional substances represented by eight additional GC peaks improved flavor quality prediction to 90 percent. Three of the four substances have been identified, and the fourth, whose chemical structure is yet to be determined, is apparently a new substance not hitherto reported. Enriching the stripped oleo-resin with the three identified chemicals substantially improves the intensity of ginger flavor. If the fourth chemical can also be readily synthesized, there is no doubt but that a synthetic, totally satisfactory ginger flavor, will be produced.

Carrot Storage

GLC profiles may be used to identify carrot varieties, and to indicate residual storage life, but the gas chromatographic procedure is not as satisfactory as mechanical and colorimetric tests for predicting flavor and appearance quality.

Functional Properties of Fish Protein Concentrate

Fish protein concentrate must, by law, contain less than 0.5 percent fat. To achieve this by the usual solvent extraction techniques, temperature of extraction is 70-80 deg. C. In the process, FPC acquires certain functional characteristics, such as insolubility and grittiness, which limit its use as an ingredient in protein enriched foods to a few bakery products, such as biscuits. In an effort to improve the functional characteristics, solvent extraction was performed at various temperatures. It was found that functional properties improve as the temperature of extraction is reduced.

Thus, to obtain a substantial improvement in functional property and yet maintain a reasonably efficient extraction process, temperature of extraction may be reduced to 40 deg. C. Lower temperatures of extraction are not effective in reducing the fat content to less than 0.5 percent.

Canned Eggplant Products

Fresh eggplants are inexpensive, nutritious and very popular. Their use as processed products is limited by cost of peeling, rapid discoloration after peeling, and development of a bitter-astringent off-flavor within several weeks after processing.

It was found that eggplants could be peeled on a commercial scale efficiently by flame or high pressure steam. Enzymatic browning was controlled by precooking (blanching) or by the use of a bi-sulfite dip. The bitter astringent off-flavor was substantially reduced, but not completely eliminated, by seed removal. Although a product so treated is acceptable, further work is contemplated to remove completely this off-flavor. Once this is accomplished a variety of canned and frozen eggplant products can be produced.

Weight Loss During Freezing and Frozen Storage

Weight loss during freezing and frozen storage is a serious problem for two reasons. One, the actual shrinkage is an economic loss, particularly of high cost foods, and secondly, the resultant "freezer burn" is unsightly and downgrades the product.

In studies with fresh hams, it was found that most of the weight loss occurred during the freezing process. The more rapid the rate of freezing, the smaller the weight loss. During the first few months' storage there was some gain in weight. After four month's storage at -5 deg. F, additional weight losses were incurred. Weight losses were reduced substantially when the frozen hams were palletized and poly-bagged or glazed. A further slight improvement in weight retention was obtained when the hams were first glazed and also poly-bagged. Amount of freezer burn was significantly correlated with weight loss.

Another technique for minimizing weight loss in freezer storage is to maintain freezer room temperatures as close as possible to coil temperatures, and to minimize temperature fluctuations, but this is difficult to accomplish in commercial freezer warehouses.

Project No. Q-58-M

TIN CONTENT INCREASES DURING REFRIGERATOR HOLDING OF CANNED FRUITS AND VEGETABLES

The common practice of the housewife to remove fruit or vegetables from tin-lined cans before holding in the refrigerator seems to be justified on the basis of tin content of products held after opening. After one week storage of opened cans of tomatoes, apples, sweet potatoes and peaches in a refrigerator held at 42 deg. F, the tin content of the product was greater than when the can was opened. Furthermore, the processing treatment, in particular the degree of blanching of the product before canning, greatly influenced the increase in tin content of the product during holding.

Apples blanched at 212 deg. F before processing showed a tin content of four ppm at time of opening and only ten ppm after one week in the refrigerator, while unblanched apples had 35 ppm of tin at opening and 173 ppm after one week. Blanched lots of sweet potatoes showed no increase during the hold period, while unblanched samples increased from 126 to 335 ppm after one week in the refrigerator. Peaches and pears normally are not blanched before processing. Canned samples of 'Magness' pears had a tin content of 120 ppm at time of opening and 247 after one week in the refrigerator. Comparable analysis for samples of 'Redskin' peaches were 154 and 370 ppm.

The activity of the polyphenolase enzyme system has been found to be associated with the degree of corrosion of tin-lined cans, and the consequent tin content of the canned product. In the observed increase in tin content of opened cans of fruits and vegetables during holding in the refrigerator, it is proposed that, upon exposure to oxygen, condensation products of the quinones produced initially by the polyphenolase reaction act as chelating agents in promoting removal of tin from the can coating. Thus, effective blanching of a product before processing would prevent corrosion after opening by inhibiting the initial formation of the quinone by the enzyme.

Project No. Q-84-B

CONTROLLED ATMOSPHERE STORAGE OF PEARS

Under normal storage at 32 deg. F the 'Magness' pear has been found to deteriorate after about three months storage. Fruit held in a controlled atmosphere (CA) storage at 32 deg. F, in which the concentration of oxygen and carbon dioxide ranged from three to five percent during the storage period, was in excellent condition when removed in February after about six months storage. The pears from CA storage ripened normally and had excellent flavor. The CA fruit were almost completely free of a skin blackening which developed during normal 32 deg. storage, and which seemed to be a precursor of a physiological breakdown of the flesh of the fruit. Analysis of volatiles emanating from ripening fruit have shown that production of acetaldehyde is associated with the development of the skin blackening.

Project No. L-79-I

NUTRITIONAL AND QUALITY STABILITY OF FRESH FOODS BY GAS EXCHANGE

Retention of fresh-like quality at ambient temperatures for several months can be accomplished only by near total (over 28 inches) evacuation of the atmosphere within and surrounding food tissues, breaking the vacuum with an enzymocidal gas such as carbon monixide, followed by a bacteriocidal gas such as ethylene oxide.

This process was totally successful with "hardware" products such as diced or sliced apples and potatoes (Fig. 1). No traces of the toxic gases were found in the foods after storage of several months in nitrogen.

More fragile products such as peaches and mushrooms could not withstand the rigorous evacuation process so that as a result of the incomplete removal of oxygen, ethylene oxide could not be applied. However, partial evacuation and flushing with carbon monoxide only, extended shelf life of fresh mushrooms from 2-3 days to 20 days, and of sliced peaches to 60 days when stored at 38-40 deg. F. A similar procedure extended shelf life of ground beef patties for at least three months. The carbon monoxide treatment of ground beef appeared to be more effective at 40 deg. F than 30 deg. F.

Retention of protein and its value as a nutrient and thiamine was not only maintained as a result of the carbon monoxide flushing, but in some instances actually increased during the 2-3 months of storage. Vitamin A was not influenced, while vitamin C in some cases showed substantial reductions as a result of this treatment. Figure 2 illustrates the difference in appearance of beef patties after 75 days storage and Figure 3, of fresh peach slices.

Project No. Q-84-A

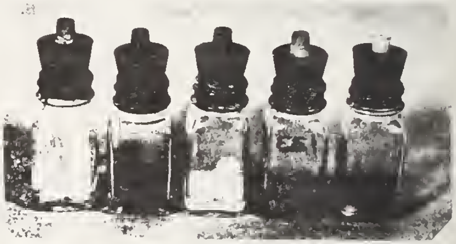


Figure 1. Potato discs after one month storage at room temperature. From left to right: Carbon monoxide flush + Ethylene oxide; Ethylene oxide + Carbon monoxide; Carbon monoxide; Prepared and stored in air; Nitrogen flush + air storage.

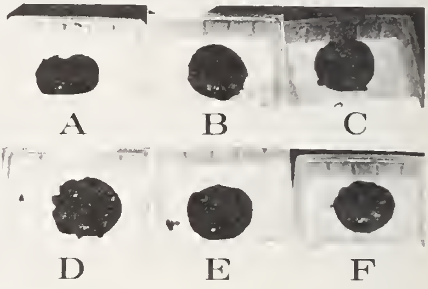


Figure 2. Beef patties after one month storage: A - air, 3 deg.C; B - CO, 3 deg.C; C - nitrogen, 3 deg.C; D - air, -2 deg.C: E - CO, -3 deg.C; and F - nitrogen, -3 deg.C.

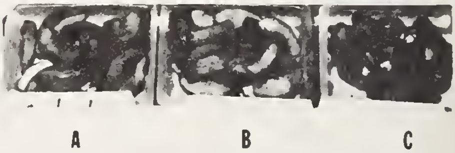


Figure 3. Sliced peaches after 21 days in sealed jars at 3 deg.C: A - air control; B - carbon monoxide flush; C - carbon monoxide flush - ethylene oxide.

DEVELOPMENT OF SPECIFICATIONS FOR CANNED FOOD QUALITY

Improving Market Quality of Sweet Corn

Eating quality of fresh, canned or frozen sweet corn depends largely on the toughness of the kernel skins (pericarp). Histological and histochemical studies showed that pericarp is formed of one-cell epicarp layer over several layers of pitted mesocarp cells, and one or two layers of cross cells. Apparently all these layers act concomitantly in resisting chewing action. However, the epicarp is more resistant than the other structures in the pericarp. It is therefore indicated that future breeding work to develop more tender sweet corn should concentrate on the development of new varieties having thin-coated epicarp cells. New histochemical techniques demonstrate that there is no lignification of the pericarp and the cell walls consist almost exclusively of cellulose and hemi-cellulose. As the sweet corn matures, all cell walls, particularly those of the epicarp, thicken, thereby causing the kernels to become tougher (Fig. 1).

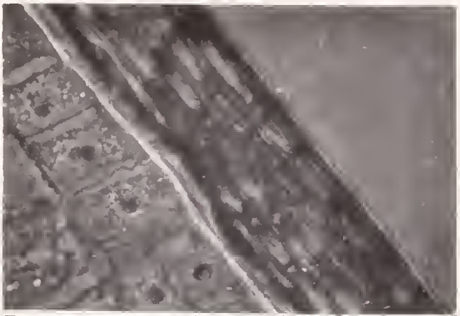


Figure 1. Longitudinal section of pericarp of sweet corn kernel showing pits in the mesocarp cells, 500X

A rapid procedure for determining whether the kernels have been frozen was developed by the use of a recording of a microprobe. This always showed a wider curve for frozen, and consequently more "mushy" kernels (Fig. 2).

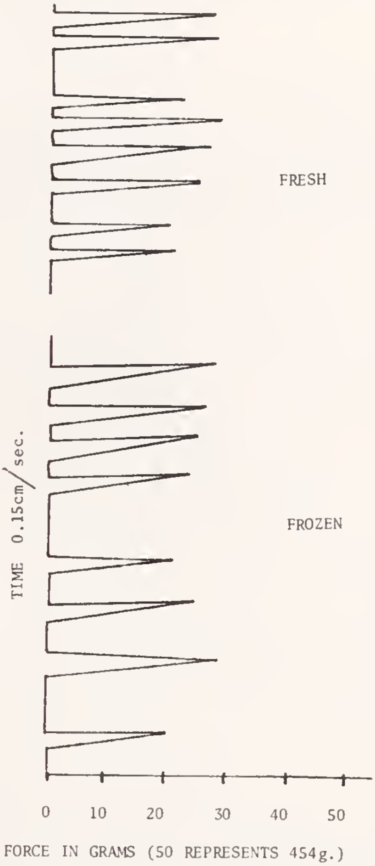


Figure 2. Microprobe recordings of individual fresh and frozen kernels

An Objective Method for Measuring Quality of Canned Tuna

There are no U.S. grades and standards for canned tuna. It is assumed that quality depends first on appearance, the lighter the better; second on texture, and third on flavor. In studies completed in 1971, it was found that consumer preference is dependent approximately equally (40 percent) on appearance and flavor and to a lesser extent (20 percent) on textural characteristics. A totally objective procedure was developed for predicting consumer acceptability with an accuracy equal to that of an expert panel by the use of the following equation: $C = -4.918 - 0.0243L + 0.224B + 0.00346S - 0.0706F + 0.804P$, where C = consumer preference, L = lightness as measured by the Hunter Color Difference Meter, B = yellowness as measured by the Hunter Color Difference Meter, S = shear value as measured by the shear press, F = percent fiber, and P = pH.

It is proposed that canned tuna scoring 4.5C or higher be considered top grade, or fancy quality. Medium or choice quality range is 3.0

to 4.5C, and standard quality range is 1.5 to 3.0C. Canned tuna scoring less than 1.5C should be graded as substandard.

Project No. Q-58-K

FOOD AND NUTRITION

For many years market value of foods, particularly fruits and vegetables, was determined on the basis of their "sensory" quality, and little attention was given to nutritive value. This undoubtedly came about mainly because of consumer disinterest, and perhaps also because ther was no rapid instrumental method for evaluating the major nutritive components so that measures of these nutrients could not be readily determined as part of the quality grade score when a specific lot of a fruit or vegetable was offered for sale. This situation has changed considerably in the last few years. Much attention is now being given to "consumer protection" since it has been determined that malnutrition is prevalent not only in developing countries, but to a very substantial extent in the U.S. as well. Work under this project followed three directions: (1) Determination of nutrient losses during processing, storage, and reconstitution and preparation of the finished product in the home; (2) Development of nutritionally enriched prepared foods; (3) Development of rapid instrumental methods for measuring the major nutritional components.

Nutritional Losses During Storage and Preparation

Effect of Temperature of Storage on Nutrient Retention

With the advent of nutritional labeling the food processor cannot rely on average nutritional values that appear in publications, such as the U.S. Handbook No. 8, since there is a vast difference from lot to lot in nutritional quantity. Factors such as temperature and duration of storage, in addition to varieties and methods of cultivation, will affect the nutrient levels of the product when purchased by the consumer. By extensive extrapolation and recalculation of data it was found that vitamins C and B_1 and protein value (not necessarily protein content) were most likely to suffer from prolonged storage at ambient temperatures while vitamins A (carotene) and niacin, and mineral nutrients remained fairly stable. In general, low temperature storage improved stability of all nutrients. Thus, frozen foods held at temperatures below 0 deg. F were the most stable nutritionally. As shown in Figure 1, however, practically all frozen foods require temperatures of about 0 deg. F to maintain sensory quality for one year. There are substantial differences, however, in their retention of vitamin C. Citrus and other relatively acid products retain vitamin C satisfactorily at temperatures as high as +40 deg. F, and most low acid vegetables retain vitamin C and sensory quality equally at about 0 deg. F. However, other fruits such as peaches and vegetables such as broccoli and other crucifers, require frozen storage temperatures of –40 deg. F to maintain vitamin C content for a full year.

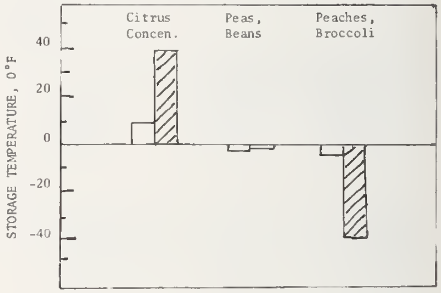


Figure 1. Frozen foods. Storage temperature required to maintain quality ☐ , and nutritive value ▨ for one year.

Supposedly stable canned (Fig. 2) and dehydrated (Fig. 3) foods also tend to sustain nutrient losses during extended storage at ambient temperatures. It appears, therefore, that most canned foods containing appreciable amounts of vitamins B_1 B_2 and C, and protein should be stored at refrigerator (30-50 deg. F) temperatures. Dehydrated foods, unless evacuated and packaged in oxygen-tight containers, should also be stored at refrigerator temperatures, and, in some instances, preferably in freezer storage.

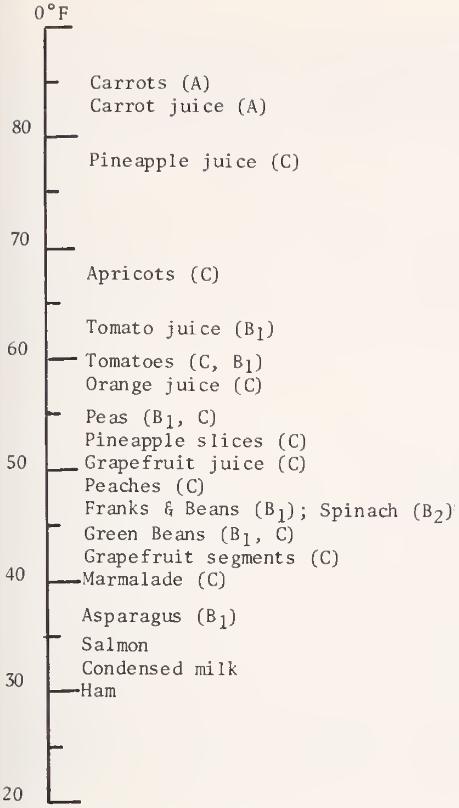


Figure 2. Canned foods. Maximum storage temperature for nutrient retention 12-18 months

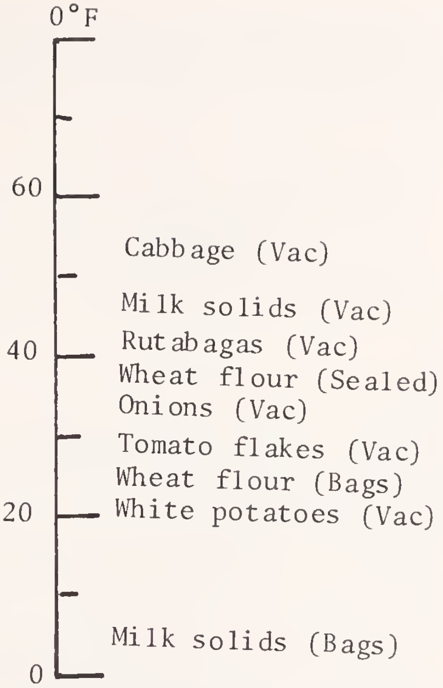


Figure 3. Dehydrated foods. Maximum storage temperatures for nutrient retention 12 months.

Effect of Preparation of Frozen Foods on Nutrient Retention

"Convenience" foods are the fastest growing segment of the food industry. They are particularly adaptable to institutional–away from home–feeding. In studies including a variety of prepared frozen foods containing animal and plant materials, it was found that wholesomeness and satisfactory quality was retained with any type of defrosting and heating equipment, if the food was heated to 175 deg. F center temperature.

As shown in Figure 4, best appearance of the product ready for consumption was obtained when the frozen product was first thawed overnight, then heated in a conventional oven. Almost as good results were obtained with a steamer oven. Microwave tended to form a dry crust and the convection and "recon" ovens caused some scorching. There was no significant difference among ovens in retention of protein value which varied from 71 to 93 percent.

Development of Nutritionally Enriched Prepared Foods

Enrichment of Potatoes

Potatoes are a good inexpensive nutritious food containing more than adequate quantities of carbohydrates and minerals, but deficient in protein. The problem, therefore, was to add sufficient protein to dehydrated potatoes to produce a mashed potato which would be a good source of protein as well as other nutrients. Fish protein concentrate was not satisfactory becuase even at levels of five percent addition, the resultant mashed potato product was unacceptable because of a gray color and grainy texture. Skim milk added at five percent, or even ten percent levels, yielded a mashed potato product that was somewhat superior to the 100 percent potato product. Soy protein isolate added at the five percent level also yielded a superior product, but addition of ten percent soy resulted in an inferior product, primarily because of the soy flavor that was undesirable. Five percent addition of the soy protein, however, increased the protein content to 12 percent–approximately the same as ten percent addition of skim milk. It was therefore concluded that addition of five percent soy protein isolate is the cheapest and best means of enriching the nutritive value of potatoes.

Retention of Nutrients in Collard Greens

Collard greens in their fresh form are excellent sources of vitamins and minerals, particularly vitamin C. Their method of preparation by the "poor" is such that much of the nutritive value is lost during the long periods of cooking and stewing. A study was undertaken to determine whether these greens could be prepared in a manner that would retain more of the nutrients, but would still be acceptable to the "target" population. It was found that a frozen product could be prepared with the addition of fatback and other condiments, including vinegar, to increase acidity, and cooked with a minimal amount of water in a closed container. In this manner, an acceptable prepared product was obtained which retained 30-40 mg percent vitamin C, as compared to only ten mg vitamin C when prepared by the conventional method. The frozen collard greens thus prepared were as good a source of vitamin C as orange juice.

Instrumental Measurement of Nutritional Components

An instrumental method for the rapid determination of the major nutrient components of protein, carbohydrate and fat was developed by the use of the "attenuated total reflectance" technique. By this method, a sample of food can be placed in the sample cell of the instrument and curves, such as those shown in Figure 5, are obtained for foods containing 100 percent protein, carbohydrate, or fat. When a food is placed in the cell a variation of these curves is obtained. By integrating the difference between the curves obtained for the food and the curves obtained for protein, carbohydrate and fat, the percentage of each component can be obtained. In Figure 6 are demonstrated two curves for products–one containing protein and starch only and another containing protein, starch and fat.

This technique was found to be satisfactory for dehydrated products rich in protein, fat and/or starch such as soybean flour, with analytical errors for protein being smaller, for fat about the same, and for carbohydrates somewhat higher than Official Methods of Analysis. For intermediate and high moisture foods the technique is not applicable because the crystal KR-5 is water soluble. Work is now in progress in an attempt to find a reflecting crystal that is resistant to water. Germanium appears promising.

Project No. Q-58-A and Q-58-U

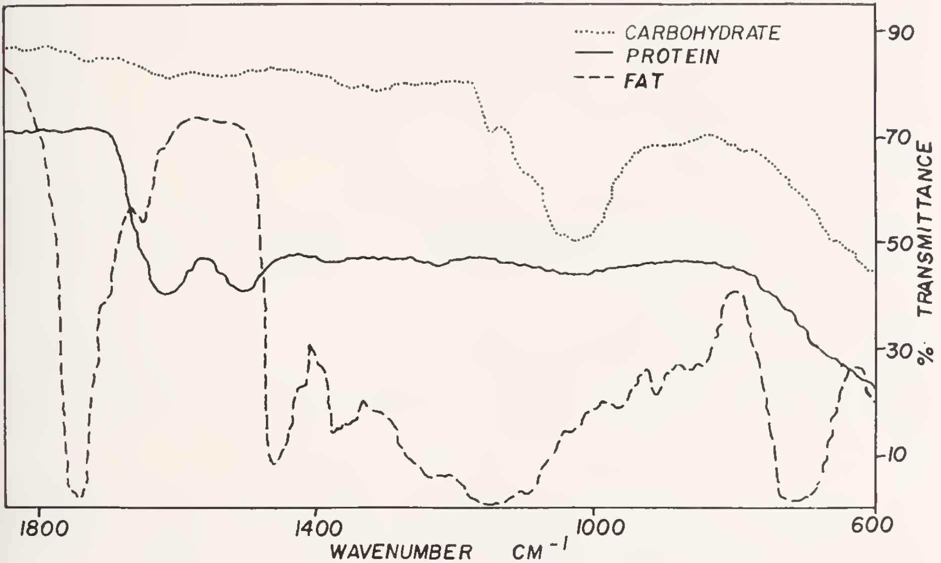


Figure 5. ATR spectra of 100% soybean oil, protein and carbohydrate

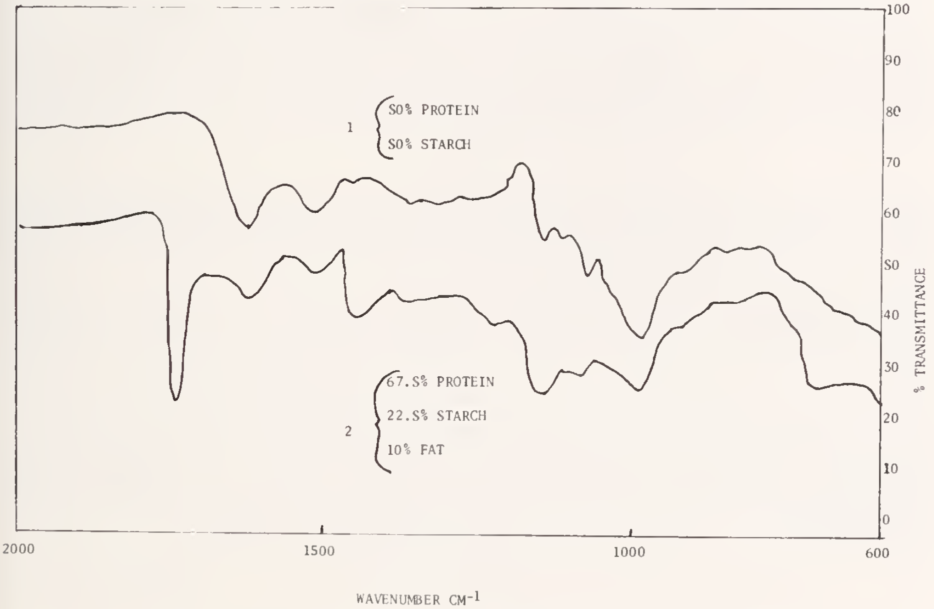


Figure 6. ATR spectra of defatted (1) and whole (@) soy flour

GREENHOUSE ROSE RESEARCH

Soils, Automation of Moisture and Fertility Control, Carbondioxide Fertilization, Plant Rejuvenation

An experiment terminated in May, 1970, involved evaluating methods of automatic watering for four soil mixtures for roses in the greenhouse, and the value of carbon dioxide fertilization of the greenhouse atmosphere under Maryland conditions. A 25-10-10 fertilizer was routinely dissolved in all water used in the experiment at the rate of five ounces per 100 gallons. This study was initiated in May, 1966 and rose production records were maintained for the next four years (October to May production periods). Severe pruning for height reduction and plant rejuvenation was done in June of each year.

The four soil mixtures made by amending field soil with peat moss, perlite, or both, resulted in little difference in rose cut flower production except that slightly poorer production and quality were recorded for the plots containing peat moss, but no perlite, during the last year. There was no difference in production or quality associated with the two methods of water distribution over the soil: 1) Stitched polyethylene "Ooze-Headers" or 2) Surface perimeter nozzles. The "on demand" control of water application attained by placing a potted rose plant on a "Moist-Scale" required 50 percent more water and resulted in the production of more roses with longer stems. Carbon dioxide produced in the greenhouse by burning propane to maintain levels of 1,000 to 1,500 ppm during the months of November to February, increased production two flowers per plant and 10-14 percent more roses had stems longer than 18 inches.

It was demonstrated in this study that it is possible to automate watering and fertilizing practices with simple, readily available equipment and that with a well aerated, well drained soil medium, to obtain high yields. These yields were further increased by the use of additional carbon dioxide in the greenhouse atmosphere during the winter months.

These same rose plants have been grown for an additional three years with the several plots subjected to different treatments in connection with the annual severe pruning and rejuvenation procedures. The general method followed was to prune all rose canes to 12-inches in June and, after keeping records of the first return crop of roses, to again record the numbers and lengths of roses produced during the months of October to December.

The suggested practice of not removing flowers for a four week period prior to pruning failed to produce more flowering shoots following pruning. Likewise, treatments consisting of whole plant sprays of several concentrations of a number of growth regulators applied at the time of pruning, failed to increase the number of strong basal shoots.

The following year a series of treatments were made with a number of growth regulating chemicals, but making these applications as whole plant sprays four weeks before pruning. In addition, several plots were lighted at night with fluorescent fixtures placed between plants at ground level for two months prior to pruning. Lighting the basal portions of the stems increased the number of strong basal shoots capable of flowering and these flowered earlier than untreated plants. An ethylene producing chemical, ethephon, induced an even greater number of strong basal shoots, still flowering earlier than untreated plants. The next year's work showed similar results from pre-treatment by spraying the whole plants with ethephon at 2,400 ppm, two to four weeks before pruning. A number of other chemicals either releasing ethylene or having anti-auxin activity have been screened for effectiveness, but have not been found beneficial at this time.

Project No. I-74-B

VEGETATIVE PROPAGATION OF PINES BY NEEDLE FASCICLES

The asexual propagation of pines by the common method of grafting, or occasionally by cuttings, is slow and the number of progeny limited. Large scale reproduction by vegetative means would be desirable in both practical and experimental work. The use of the dwarf shoots or needle fascicles of pine as reproductive units could offer the possibility of obtaining a large number of propagules if such a procedure were possible. The potential exists, but reliable means of first, rooting these dwarf shoots and secondly, obtaining shoot growth from what in many cases is an unorganized group of cells, has not been reliably demonstrated.

Work at this station has demonstrated the potential in several species of pine, and present research has continued the study of cultural, chemical and anatomical aspects involved in rooting needle fascicles and in the development and continued growth of the vegetative shoot. Several problems in this work have been studied involving the effects of chilling, photoperiod, pruning (removal of terminal buds) and chemical treatment of the parent plants, the rooting medium, temperature, misting, use of auxins in the rooting of dwarf shoots, and a study of the morphological and anatomical changes in the apices of dwarf shoots during development.

To ascertain the most effective rooting hormone, medium and time of propagation, fascicles of white pine, Scotch pine and ponderosa pine were removed from parent plants at intervals during the winter months and, following treatment with different concentration of auxin in talc, were inserted in different materials for rooting under intermittent mist. Treatment of fascicles taken in January with 8/10 percent indolebutyric acid in talc and inserted in perlite was the best combination of treatments for rooting. In other experiments, it was shown that best rooting was also obtained when the fascicles had been subjected to low temperatures so that the chilling requirement for continued growth had been fullfilled.

Following a number of treatments in which the photoperiod received by the parent plants was controlled, it was found that fascicles removed from parent plants which had been subjected to long, or continuous photoperiods were reduced in their ability to root, but that shortened photoperiods failed to stimulate rooting over the use of natural day lengths. Having classified the fascicles in this study as to the stage of development of buds within the apex of the dwarf shoot or needle fascicle, it was also shown that fascicles with predeveloped buds were superior in their ability to root, and only those with predeveloped buds seemed capable of continued shoot development.

Further work concentrated on treatments to facilitate development of the dwarf shoots for better rooting and shoot growth potential. Removal of the terminal bud of the growing stem encourages development of buds within only a few dwarf shoots, so many combinations of time of removal and the use of many types of growth regulators were resorted to. Auxins, anti-auxins, gibberellins, antigibberellins and cytokinins were used at intervals during the growing season with or without removal of the apical bud. Current results have indicated that the most successful treatment was a combination of de-budding with a foliar spray of the cytokinin N^6-benzyladenine in the early stages of growth.

Certain parent plants, particularly in white pine, have been discovered to have a much greater ability to reproduce by the use of dwarf shoots. This suggests a genetic variation in plants carrying this trait, and work is under way to study and test the possibility of selecting and/or breeding for this characteristic.

A study is being made of the morphological and anatomical differences in the dwarf shoots and long shoots during the needle-development period. Samples have been collected at bi-weekly intervals during the growing season. Examination of median sections of prepared slides has showed great similarity of apices of long and dwarf shoots in the early stages of development. Dwarf shoot apices differ from long shoot apices in that they contain no axillary buds, have fewer cataphylls, a less developed central zone and no procambrial strands. Further evaluation of differences in the two types of apices is being made.

Project No. Md. L-100

A STUDY OF REGIONAL ADAPTATION OF CERTAIN VEGETABLE CROPS AND VARIETIES IN MARYLAND

Variety studies were conducted with broccoli, pickling cucumbers, sweet corn and watermelons. Two new lines of broccoli, Experimental Hybrids No. four and No. eight of the T. Sakata Company, were outstanding for production of center heads, concentration of maturity and head type. Hybrids 8382 and 8383 of the Dessert Seed Company continued to do well, but vary in performance from year to year.

The gynoecious hybrids Explorer, Frontier, Pioneer and Southern Cross were outstanding varieties of pickling cucumbers when grown for once-over mechanical harvest. The standard variety SMR 58 is one of the best of the non-hybrids, but is a few days later and usually does not give as high production as the above hybrids.

Target A and Longchief 65 are two new sweet corn lines which compare favorably with the standard NK-199. Golden Queen is productive and has excellent quality but is seven to ten days later than NK-199.

The new Princess watermelon compares favorably with the standard Charleston Gray and has smaller seeds. Garrisonian and Jubilee are good varieties with long striped fruits. None of the new F_1 hybrids appears to have the productivity, size or shipping qualities required for the Maryland market.

Varieties of white sweet corn for fresh market were grown and evaluated at the Plant Research Farm. Silver Queen is the standard variety. It is productive and of excellent quality but is late maturing (92 days). Early varieties with high quality are needed. White Jewel is the earliest white with acceptable qualities. It is seven to ten days earlier than Silver Queen, has good quality and is tolerant to bacterial wilt and northern leaf blight. White Dutch matures about the same time as White Jewel but is disease susceptible. A new line, WH 2479, from Joseph Harris Co., has excellent quality and is three to five days earlier than Silver Queen. It will be released and named in 1973. The earliest white varieties, Spring White and Silver Sweet, are very susceptible to bacterial wilt.

Three varieties and eight P.I. lines of mung beans were evaluated during 1972. Plant growth characteristics, response to soil type and yield were determined. Results indicate that Berken variety may be successfully grown on light sandy soil from plantings as late as early July. Morden 39 variety was determinate, but the plant was too small and not as high yielding as Berken. The other variety, Thailand, and all eight P.I. lines were judged as being too viney and indeterminate to be of commercial value.

Project No. Q-74

SUITABILITY OF NEW VARIETIES OF HORTICULTURAL CROPS FOR CANNING AND FREEZING

Vegetables tested at Salisbury for growth characteristics and processing suitability during 1970 included 19 sweet corn, 16 peas, four lima bean and 37 snap bean breeding lines and varieties. Vegetables tested during 1971 included 44 snap bean, 25 sweet corn and 20 lima bean lines and varieties. Vegetables tested during 1972 included 34 snap bean, 22 sweet corn, six pea and 11 lima bean varieties and lines. All entries were evaluated in the field, yield and raw product quality data obtained, and samples were frozen and canned to determine processing quality.

Three years of testing sweet corn, snap beans, peas and lima beans indicate the following named varieties and advanced breeding lines have considerable merit to processors of the mid-Atlantic area. These entries have been rated on field performance as well as processing qualities.

Sweet Corn – The variety NK-199 is still considered the leading processing variety, due in large part to field performance predictability. Several other lines and varieties, such as Buttersweet, Stylepak, Wondergold, Code 556, 68-2626, 1323 and Goldie had good processing quality, but none were judged to be superior to NK-199 in field performance.

Snap Beans – Several new snap bean varieties and lines have looked promising. In addition to good standard varieties such as Gallatin Valley 50, Early Gallatin and Tenderette, promising introductions include Green Isle, Wondergreen. Slenderette and E-1208 in small sieve green podded types. Promising large sieve green podded types include Lake Shasta, Galagreen, IC-32A, Rainer, Thor, Blue Lake Supreme, IC-69A, IC-70 and IC-67. Promising wax bush beans include Golderop and Goldette.

Lima Beans – Several USDA baby lima and green seeded Fordhook selections have been evaluated. Baby lima selection No. 569 was named Bridgeton and released. Trial results to date indicate that Bridgeton is superior in yield and quality to Thaxter. Green seeded Fordhook selections No. 169, 269 and 369 appear to have superior processing quality, but are not higher yielding than Fordhook 242.

Peas – Most pea varieties and lines have been of larger seeded freezer type sweet peas. Promising varieties include Trident, Neptune, Perfected Freezer 400 and Green Arrow. The small sieve variety, Mini, appears promising for freezing or canning.

Project No. Q-58-N

ENVIRONMENTAL FACTORS AND CULTURAL PRACTICES IN RELATION TO THE GROWTH AND FRUITING RESPONSES OF FRUITS

Greater Apple Yield – A New Plus From Alar

The versatile growth regulator, succinic acid - 2,2-dimethyl hydrazide (Alar), is now used in production of several apple varieties. This provides increased firmness and fruit color at harvest, control of preharvest drop of fruits and increased storage life. A continuous study in Western Maryland involving sustained spray treatments on the same trees for four seasons has demonstrated that concentrate applications of Alar at low volume per acre is not satisfactory for control of preharvest fruit drop, whereas dilute sprays are effective.

This experiment has been carried out on the Stayman variety for four seasons, or two "off" years and two "on" years. Alternate bearing has been moderated by annual applications of Alar. At the end of the four years, Alar-sprayed trees yielded a total of 16 bushels per tree more than control trees. This increased yield has been achieved in spite of no differences in blossoming over these four seasons. It appears that along with chemical thinning, Alar offers the possibility of greater control over the age-old problem of biennial bearing of the apple.

Orchard Herbicides Mean Less Need For Nitrogen

Effective weed control in orchards is normally followed by a vigor response in the trees. This has usually been ascribed to better water relations due to the removal of weeds as competitors for soil water. A six-year study has been conducted in Western Maryland to study the herbicide-nitrogen fertilization interaction in growth and fruiting. Complete weed control has been achieved with herbicides. Variable nitrogen applications have been used.

In the fourth season, trees annually fertilized with nitrogen were found to contain 2.19 percent nitrogen in the leaves in mid-summer where no herbicides had been used, and 2.30 percent nitrogen with herbicides. Trees which had been treated with herbicides, but had received no nitrogen for four years, were found to contain 2.22 percent nitrogen in the leaves. Leaf samples from these trees for the fifth and sixth year have not yet been analyzed, but tree growth and fruiting records indicate that trees with herbicides and no nitrogen for six seasons are still in acceptable vigor.

Leaching of surface-applied nitrogen into ground water is a world-wide problem. This work indicates that with effective herbicides, nitrogen use in the orchard may be substantially reduced with no dilution of fruitfulness of the orchard. Studies on this problem are continuing.

Project No. L-74

SLOW RELEASE NITROGEN FOR STRAWBERRY NURSERIES

Strawberry nursery stock in Maryland is grown on sandy loams to permit the digging of dormant plants during the winter. The low cation exchange capacity of the soils, however, poses problems in the maintenance of adequate levels of nitrogen, potassium, boron and magnesium for good growth. Sulfur-coated urea (SCU) was applied in various combinations and application dates to determine if the SCU would reduce leaching losses. Comparisons were made with regular urea in single and split applications, the standard nitrogen plus potassium program commonly used by the nurseries, and the special program initiated to overcome the excessive leaching caused by the abnormal rainfall (33.25 inches for April-September) in 1972.

Results from the 1972 special program were poor, because the first nitrogen applications were delayed. Loss of part of the first application due to rain, followed by Hurricane Agnes after the second, resulted in low nitrogen levels even though approximately three times as much nitrogen was applied as in the other treatments. The sulfur-coated urea treatments produced good results. The slower available SCU-20 performed best. Better results would have been obtained if the excessive rainfall had been anticipated and the experiment designed for a supplemental nitrogen application in early September. The standard fertility program provided 75 lbs. nitrogen and 66 lbs. potash; the 1972 special program provided 168 lbs. nitrogen, 152 lbs. potash, and 20 lbs. phosphate; the SCU-20 program was 60 lbs. nitrogen and 70 lbs. potash per acre. Plant production was 112,000; 80,000 and 184,000 per acre, respectively. The increased production of the SCU-20 treatment was valued at $2,160 gross or $1,440 net per acre. In addition, cost of fertilizer and application was reduced.

Project No. L-74

CANTALOUPE BREEDING AND SELECTION WITH PARTICULAR REFERENCE TO QUALITY AND RESISTANCE TO DEFOLIATION

The cantaloupe breeding project has been directed toward the development of high quality varieties resistant to Fusarium wilt and leaf blight. Both diseases are present each year and the result is reduced production and quality.

A field procedure has been established for screening for resistance to Fusarium wilt and several resistant breeding lines have been developed. These lines have been crossed with high quality lines in an effort to develop new varieties.

A field procedure has also been established for screening for resistance to leaf blight. Two resistant lines have been selected for a study of inheritance of resistance and development of resistant varieties. For the inheritance study, a greenhouse seedling test has been developed, but the results have been inconsistent from test to test and further study is needed in developing a reliable test.

Project No. Q-81

INTERRELATIONS OF CULTURAL PROCEDURES TO THE MECHANICAL HARVESTING OF TOMATOES

Successful mechanized harvesting of tomatoes is dependent upon suitable varieties, proper cultural practices and mechanical harvesters. Since suitable varieties and harvesters are available, the cultural practices have become the major factor in the mechanization program.

The objective in the field production phase is concentrated ripening so that there can be maximum yield of marketable fruit from a once-over harvest. All the cultural practices from time of seeding or transplanting to harvesting are important because each has some effect on the concentration of ripening. Major emphasis has been placed on fertilization practices, direct seeding, plant density and growth regulators.

The program of applying the fertilizer before planting and in the early growth period has given the best concentration of ripening. The objective is to have nitrogen available for plant growth, fruit set and fruit enlargement with the nitrogen supply being largely depleted when the fruits begin to ripen.

Direct seeding is important in the mechanization program, because with this practice there can be a reduction of production costs, lengthening of production season and higher plant populations. The most effective and efficient seeding technique has been precision seeding in clumps (3-5 seeds per clump) at the desired in-row spacings. The precision seeding has been achieved with special seeders or with seeds embedded in water soluble tape. The seeding in clumps gives a much greater assurance of obtaining a uniform stand of plants. The clumping of plants has had no effect on marketable fruit yields. There have been no differences in yields from clumps (3 plants) and single plants at the same in-row spacing. A program involving both direct seeding and transplanting has lengthened the production season and provided for scheduled harvesting.

'Chico III', a determinate, small vine cultivar, has been used in plant density studies with clumps (3 plants) at 6, 12 and 16 inches in the row (49,016; 24,508; 18,380 plants per acre respectively) with rows 64 inches apart. Yield and percentage of marketable fruit tended to be higher at the six-inch spacing, but the differences were not statistically significant. With the small vine cultivars, such as 'Chico HP, 'Caroline', 'Dorchester', 'Campbell' 28', clumps (2-3 plants) at spacings of 6 to 12 inches would be suitable for direct-seeded plantings.

The use of growth regulators for stimulating and concentrating fruit ripening has been studied with several tomato varieties. Ethephon [(2-chloroethyl) phosphonic acid] applied as a foliar spray at the rate of 0.8 lb/A resulted in increased yield and percentage of marketable fruit and decreased yield and percentage of green fruit from a once-over harvest 15 days after treatment (harvest was 10-14 days earlier than would normally be made). There was no effect on yield and percentage of cull fruit. There was a slight decrease in color, slight increase in pH and no effect on soluble soilds, total solids and ascorbic acid. Ethephon has potential use in accelerating ripening for earlier once-over harvest without sacrificing yield and quality.

Ethephon alone and in combination with CPTA [2-(4-chlorophenylthio)-triethylamine hydrochloride] applied as a foliar spray resulted in increased yield of marketable fruit from once-over harvest 14 days after treatment. The marketable fruit yield from the ethephon plus CPTA treatment tended to be higher than from ethephon alone, but the differences were not significant. Low volume (10 gal. liq./A) spray equipment has been shown to be practical for application of ethephon to tomatoes.

The extension of the tomato production season to mid-October was shown to be practical in direct seeding and disease control studies. Yield and quality were acceptable from tomatoes direct-seeded during the first two weeks of June and harvested October 5-20. Two applications of Difolatan 4F at the rate of 2.0 gal. /A/application resulted in full season control of anthracnose and early blight in late tomatoes.

Project No. Q-77-C

THE DYNAMICS AND ENERGETICS OF THE SOIL–PLANT–ATMOSPHERE CONTINUUM (SPAC)

Water Use by Vegetable Crops

The effects of various cultural practices on water use by cucumbers, tomatoes and broccoli were studied in field plots. Treatments included different soil moistures, different plant populations including varying in-row and between-row spacings, different varietal types and different times of planting to allow comparisons between different stages of growth. Rates of depletion of water in the total root zone as well as depletion from various depths in the soil were measured.

Results show that rates of water depletion are greatly influenced by irrigation treatments and to a lesser extent by stage of growth of the crop and planting density, and least of all by variety. With all three crops, a high percentage of the water is lost from the top soil - the 0 to 9-inch depth. With treatments resulting in very little water stress, practically all water loss is from this zone. With broccoli and cucumbers very little water was lost from depths greater than 21 inches, except under conditions of high soil moisture stress. With tomatoes some water depletion occurred from below 45 inches.

Effects of Soil Water Stress on Growth of Cucumbers

Slicing cucumbers - variety Gemini Hybrid - were grown under four soil moisture regimes in field plots protected by polyethylene covers to exclude unwanted rain. Soil moisture treatments included the following: A) Irrigation when the soil water potential (SWP) at the five-inch depth decreased to -1½ bars, B) Irrigation when the SWP at nine inches reached -1½ bars, C) Irrigation when the SWP at nine inches reached -2½ bars, and D) Irrigation when the SWP at nine inches reached -8 to -10 bars. Growth rates of cucumber fruits were determined by measuring the length and circumference of individual fruits at intervals from pollination to harvest. Since the presence of developing fruits on cucumber plants tends to inhibit growth of other fruit on the same plant, fruit load was restricted to one pollinated fruit per plant at any given time. Under these conditions this wide range in soil water stress had practically no effect on the growth or market quality of cucumber fruits. When severe soil water stress resulted in wilting of cucumber leaves so that the fruits were exposed to the sun, fruits became undesirably yellow, instead of a normal green color. Soil water stress did not result in crooked or malformed fruits. It is known, however, that cucumbers show excellent response to irrigation on similar soils in this area.

Project No. Q-83 (Regional Project NE-48 Revised)

CONCENTRATION BY DIRECTIONAL COOLING

Previous studies demonstrated that as a food containing soluble solids such as fruit or vegetable juice is cooled, when the surface begins to freeze, the soluble solids descend to the bottom of the container. When such a cooling system is not closed so that the pressure of ice formation does not force some of the solids towards the top, the solids content of the material towards the top of the container is diluted to as little as 25 percent of the original solids content, while at the bottom layer the solids will concentrate three to six fold. Thus, a juice having 10 percent solids can be separated by this means into a "fruit drink" having approximately one-third of the single strength juice, and a concentrate that is three to six times that of the single strength juice. A schematic diagram of equipment utilizing this principle is shown in Figure 1. A freezing plate or belt is at the top, leaving an opening at one end for introduction of juice. As the juice moves laterally under the cooling medium, it is cooled, and solids begin their descent. As the juice travels gradually across to the opposite end of the container, being continuously cooled, the diluted juice will emerge from an orifice towards the top of the tank, and the concentrated juice from an orifice at or near the bottom of the tank. It appears to be possible to make this separation with only a minimal amount of actual freezing, thereby making such a process relatively inexpensive. The diluted juice can be marketed as a "fruit drink", probably with the addition of sugar, while the concentrate may be marketed as such.

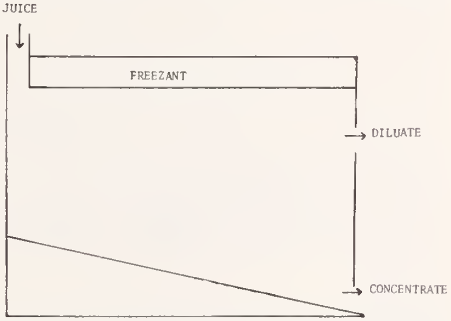


Figure 1. Schematic diagram of equipment for simultaneous production of fruit drinks and concentrates

These results were obtained under static conditions so that the downward solids concentration could be explained by effect of gravity. Thus, another freeze concentrating unit was constructed (Fig. 2) capable of providing forces greater than 1.0 gravity. Sugar, salt solutions, and fruit juices are being tested to determine the optimal gravitational forces and turbulences required to concentrate the solid phase and to purify the water phase.

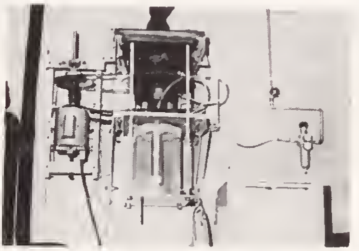


Figure 2. Prototype of a centrifugal freeze-concentrator

Project No. Q-84-C

EFFICACY AND SELECTIVITY OF HERBICIDES FOR WEED CONTROL IN TRUCK CROPS

With the rapid change to mechanical harvesting of many vegetables, the development of more effective chemical weed control treatments has been required by the vegetable industry. Commercial herbicides presently used for sweet potatoes were shown to require cultivation for acceptable weed control and maximum yields. Mechanical harvest of tomatoes is increasing and requires almost perfect weed control for the proper operation of harvesters. An experimental herbicide EL-179 (isopropalin) is effective on seeded tomatoes for grass control and has recently been registered for commercial use. Metribuzin has shown potential as a postemergence treatment in tomatoes for control of several broadleaf weeds. R-7465 and U27-267 were other experimental herbicides with acceptable selectivity in tomatoes, strawberries and sweet potatoes. These herbicides provide acceptable weed control. A-820 has also shown herbicidal efficacy in seeded tomatoes and snapbeans.

Most cantaloupes in Maryland are grown with clear plastic mulch which requires a weed control treatment under the plastic to prevent weed growth. Fumigation is presently used to obtain acceptable weed control, however, grower costs could be reduced if an effective herbicide could be developed for use. Research has indicated that A-820 and dinoseb are effective herbicides for this purpose.

Strawberry nurserymen in Maryland do not have a recommended herbicide treatment for nutsedge control in plant production beds. Since nurserymen normally fumigate for disease control, fumigant treatments at slightly higher rates than those necessary for disease control were evaluated for nutsedge control for three years. The fumigants Vorlex, Telone C, and DD-Pic were applied in the fall at soil temperatures of 50 deg. F and 40 deg. F at the six-inch depth without plastic tarp cover. Fumigation was more effective at soil temperatures of 50 deg. F than at 40 deg. F, and acceptable nutsedge control was obtained with Vorlex at 30 gal/A and Telone C or DD-Pic at 40 gal/A, when applied at a 50 deg. F soil temperature.

Winter annual weeds continue to be a problem for strawberry growers. Diphenamid is an effective post-emergence herbicide for the control of a winter weed-ticklegrass (*Agrostis hyemalis* (Walt.) BSP).

An evaluation of 15 herbicides for the control of ivyleaf morning glory (*Ipomoea hederacea* Jacq.); *Impomoea hederacea* Jacq., var. *intergriuscula* Gray; and white morning glory (*Ipomoea lucunosa* L.) in sweet corn showed that there were no differences in the control of these three weed species by the herbicides tested.

A preliminary study of growing vegetables by a no-tillage system in a rye cover crop was made in 1972 with tomato, lima beans and cucumber. Yields of tomato and lima beans grown with a no-tillage culture were equivalent to yields with conventional plowing and cultural practices. An apparent increase in rate of growth and maturity occurred with no-tillage culture compared to conventional tillage.

The light soils of the Vegetable Research Farm provide a distinct soil type for the preliminary screening of experimental herbicides in logarithmic rate multi-crop trials, and a total of 39 experimental herbicide treatments were tested in three years.

Project No. Q-77B

TOMATO BREEDING AND SELECTION WITH PARTICULAR REFERENCE TO ADAPTATION TO MECHANICAL HARVEST AND TO PROCESSING

The tomato breeding project has been directed toward the development and evaluation of processing varieties suitable for a mechanized industry. The need for new varieties has arisen because other production areas have mechanized their harvesting and processing and the Maryland industry must do likewise to remain competitive.

Whole, peeled tomatoes comprise a large portion of the Maryland pack. Extensive efforts have been made in the development of coreless varieties that can be mechanically harvested, transported in bulk, mechanically peeled and whole-packed without coring. The coreless feature includes a small stem scar and small internal core material. Two coreless cultivars, 'Caroline' and 'Dorchester' were released in 1972. 'Caroline' is a medium early maturing, small-vined, crack resistant and Fusarium resistant variety. The fruits are globe-oval and 2.0 to 2.5 ounces. It is suitable for both whole pack and tomato products. 'Dorchester' is a midseason-late maturing, medium-vined, highly productive, highly crack and break resistant and Fusarium resistant variety. Fruits are oval-elongate ranging up to 3.0 inches in length and 2-1/4 inches in diameter. Fruit weight ranges from 2.0 to 3.0 ounces. Color, wholeness and firmness are excellent in whole pack. It is also suitable for tomato products.

Anthracnose is a serious disease of processing tomatoes in Maryland. There is the need for resistant varieties. The puncture inoculation technique developed at Maryland has been used to screen for resistance. Three moderately resistant lines and one highly resistant line have been developed and are being used in the breeding program.

Project No. Q-81-D

FRUIT BREEDING

Fruit breeding programs in Maryland include the cooperative arrangement between USDA and Maryland to develop disease resistant, high quality, productive strawberry cultivars and grapes. The Maryland program is also aimed at developing improved peach, raspberry, blackberry and strawberry cultivars.

Some of the more recent strawberry cultivars developed by the USDA-Maryland cooperative program are Midway, Sunrise, Guardian and Redchief. Several more selections are in the final stages of evaluation. The varieties Bluestar and Rosebelle were released from a short term cooperative grape breeding program.

Efforts by the Maryland program to develop raspberry cultivars adaptable to Maryland's fluctuating winter temperatures, as well as yield good crops of high quality fruit, have resulted in the release of Citadel, Reveille, Scepter, Sentinel and Sentry red raspberry cultivars and the black raspberry Allegany. Additional red and black raspberry selections are being evaluated for possible release.

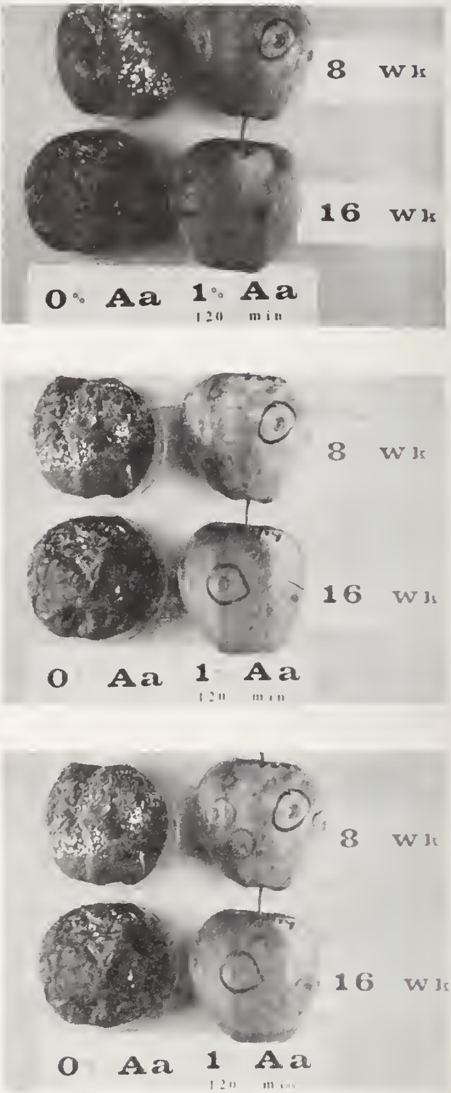
The Marlate strawberry is a late maturing, large fruited, high quality strawberry for the home garden and retail market.

High quality peach varieties maturing after Redskin and Elberta were needed for the commercial peach grower and the retail market grower. Recent releases from this program include Marglow, Marhigh, Marland, Marqueen, Marsun, Marpride and So Good. These cultivars extend the harvest season from September 1 through October 5. Several other selections that mature from August 25 to September 7 are being evaluated for possible release.

Project No. L-73

CONTROL OF PESTS OF PERISHABLE FOOD COMMODITIES IN MARKETING CHANNELS

Previous work at Maryland has demonstrated that 5 to 20 percent CO_2 in storage atmospheres causes strawberries to produce more acetaldehyde. The work also indicated that the acetaldehyde would control decay-causing microorganisms on the strawberries. Acetaldehyde is a naturally occuring product of metabolism in most living organisms. It is also cleared by EPA on a nonrestricted basis as a food additive and flavoring agent. The fact that acetaldehyde is a naturally occuring product, that the use of manufactured pesticides is being restricted, and that annual loss of fresh fruits and vegetables in marketing channels exceeds 100 million dollars, prompted the Department of Horticulture to investigate the possibilities of using acetaldehyde to control the major postharvest decay-causing microorganisms. Investigations were initiated to (1) Determine the acetaldehyde vapor concentrations and exposures required to control 10 major postharvest decay-causing pathogens growing on artificial media, (2) Determine the effectiveness of the lethal concentrations on pathogen inoculated fruits packed in commercially used marketing containers, (3) Determine the effective but nonphytotoxic acetaldehyde concentrations on strawberries, apples, plums and nectarines, (4) Determine the sensory and metabolic changes that occur in the fruit as a result of the acetaldehyde treatment, and (5) Collect absorption data on apples and strawberries treated with acetaldehyde in order to complete petition to EPA for clearance of acetaldehyde as a pesticide.



Acetaldehyde vapor control of blue mold (Penicillium expansum) on Red Delicious apples. All four apples containing stem punctures were inoculated with penicillium spores. The bottom pair were treated with 1% acetaldehyde vapors for 120 minutes whereas the middle pair received no acetaldehyde. The top pair was held eight weeks at 70 deg.F, the bottom pair sixteen weeks at 70 deg.F, after treatment

Acetaldehyde Control of Pathogens on Artificial Media

Artificial media inoculated with fungus spores or bacteria cells from 10 major decay-causing microorganisms were exposed to several acetaldehyde vapor concentrations for various periods of time. The cultures were held under ideal growing conditions (27%C and 85%R.H. for 14 days) and control recorded only when no growth occured at the end of the test period. All 10 pathogens were killed when exposed 30 seconds to 20 percent acetaldehyde vapor. The lowest acetaldehyde concentrations and exposure giving 100 percent control are:

Penicillium expansum (blue mold) .50 percent for 120 minutes;

Penicillium italicum (blue mold) .75 percent for 120 minutes;

Penicillium digitatum (green mold) .75 percent for 120 minutes;

Rhizopus stolonifer (soft rot) .75 percent for 90 minutes;

Monilinia fructicola (brown rot) .25 percent for 70 minutes;

Botrytis cinerea (grey mold) .75 percent for 90 minutes;

Alternaria tenuis (Alternaria rot) .75 percent for 60 minutes;

Glomerella cingulata (bitter rot) .75 for 60 minutes;

Erwinia carotovora (bacterial soft rot) .25 percent for 60 minutes;

Pseudomonas fluorescens (bacterial soft rot) .25 percent for 90 minutes.

Acetaldehyde Control of Pathogens on Inoculated Fruits

Methley and Shiro plums as well as Cherokee nectarines were inoculated with *Monilinia fructicola* (brown rot), treated with acetaldehyde vapors, and held for 7 days. Fruit treated with acetaldehyde vapors at one percent for 60 minutes were all sound. There was no decay at the end of the 7-day storage, whereas all fruits not treated with acetaldehyde were completely decayed. Red and Golden Delicious apples were inoculated with *Penicillium expansum* (blue mold), treated with acetaldehyde vapor and then held 30 days at 24 deg. C and 75 percent R.H. A 240 minute exposure to one percent acetaldehyde vapor gave 99 percent control of blue mold. All untreated fruit decayed. The one percent decay occured where the inoculated punctures were in contact with the tray and were not exposed to the acetaldehyde vapor.

Midway strawberries were inoculated with *Botrytis cinerea* (grey mold) and *Rhizopus stolonifer* (soft rot) treated with acetaldehyde vapor and held six days at 15 deg.C. and 65 percent R.H. Fruit treated with acetaldehyde vapor for 60 minutes developed four percent Botrytis rot and three percent Rhizopus rot at the end of the 6-day storage period. Untreated fruit developed 55 and 52 percent rot, respectively.

Berries grown in Mexico and purchased from the Washington produce market were inoculated with *Botrytis cinerea* and held 11 days at 10 deg.C. Fruit treated 60 minutes with one percent acetaldehyde had 90 percent undecayed fruit. The untreated checks had only three percent undecayed fruit.

Red raspberries were inoculated with *Botrytis cinerea* (grey mold), treated with acetaldehyde vapor and held three days at 13 deg.C and 65 percent R.H. Complete control of Botrytis was obtained when the fruit was treated with 0.25 percent acetaldehyde vapor for 70 minutes whereas 100 percent infection occured in the untreated berries.

Nonphytotoxic Levels

Even though acetaldehyde is a naturally occuring product of metabolism, it will injure plant tissue, as well as kill microorganisms at high levels and prolonged exposure periods. Taste and appearance panel ratings indicate that no injury or flavor changes occured in strawberries, apples, plums and nectarines at acetaldehyde levels and exposures that gave effective decay control. Soluble solids, titratable acidity and pH tests indicated no change in strawberries due to treatment. However, one percent acetaldehyde for 30 minutes increased ascorbic acid content of some strawberry varieties whereas 10 percent for seven minutes decreased ascorbic acid. There were no differences between checks and the one percent for 60 minute treatment.

Practical Control Methods

Tests with strawberries, apples, plums and nectarines in some of the commercial containers used to package and market the produce indicate that it is practical to fumigate the fruit after it is packaged in its shipping container. Decay-causing pathogens on the surface of the fruit treated with acetaldehyde vapors are killed. Therefore, the fruit will not decay unless it is reinoculated. Since the fruit is sterilized inside its shipping container, reinoculation should not occur unless unsanitary conditions exist at the supermarket when the produce is displayed. Special gas-tight treatment chambers will be required for commercial application. These are available in the form of CA rooms for apples and vacuum cooling rooms for lettuce and strawberries. Results to date indicate that any fruit or vegetable having sufficient wax in the cuticle to protect it against the phytoxic effect of the acetaldehyde vapors can be successfully treated to prevent postharvest decay.

EPA Clearance

Petitions have been filed with EPA for clearance to use acetaldehyde as a postharvest pesticide on apples and strawberries. Since acetaldehyde already has EPA clearance as a food additive and flavoring agent on an unrestricted basis, the only additional data required is acetaldehyde absorption by the treated fruit. Most of this data has been obtained for apples and similar data will be obtained for strawberries during 1973.

Project No. L-79-G

PROJECT REPORTS

HOME ECONOMICS

THE IMPROVEMENT OF COLOR IN COOKED GREEN VEGETABLES BY USE OF AN AMMONIUM COMPOUND

INTRODUCTION

Cooked vegetables have been called the "neglected corner of the plate." Studies carried out by the United States Department of Agriculture have found a decrease in consumption of vegetables by the population of this country. Since it is a well-known fact that vegetables make a significant contribution of vitamins and minerals to the diet, it is important that this decreased consumption be reversed. Therefore, there is a need for research on methods of improving the eating quality of processed and cooked vegetables, especially green vegetables.

Such a study has been undertaken at the University. In this study an alkaline substance, ammonium bicarbonate, is being used in an attempt to improve the color of processed and/or cooked green vegetables. Before using this compound, its safety was evaluated. Ammonium bicarbonate was used years ago in the home as a leavening agent for baked products. It is used today in some low-sodium baking powders. The Food and Drug Administration has listed this compound as "Generally Recognized as Safe-GRAS." Physiological studies have shown that the compound is metabolized in the body and excreted as urea, a waste product normally formed from the protein foods we eat.

Since this alkaline compound could be expected to prevent the destruction of the green color during processing and cooking vegetables, it has been used in several ways: (1) In the blanching waters of frozen vegetables, (2) In the cooking waters of fresh and frozen vegetables and (3) As an additive in steam blanching, a process which usually results in vegetables of poorer color, but higher nutritive value than water blanching.

COMBINED USE OF AMMONIUM BICARBONATE FOR BLANCHING AND COOKING GREEN BEANS

A dilute solution of ammonium bicarbonate was used in blanching, in cooking and in combined blanching and cooking of green beans. It was found that beans blanched and cooked in ammonium bicarbonate were much higher in chlorophyll (green pigment) and lower in acids than those in which water alone was used. Six judges scored the treated beans higher in color, flavor and overall eating quality than those blanched and cooked in water. Beans which has been either blanched or cooked with ammonium bicarbonate were better in color and palatability than those in which water was used, but were not as improved as when ammonium bicarbonate was used in both balnching and cooking. Although use of baking soda (a compound similar to ammonium bicarbonate) is not recommended in cooking vegetables, because it causes increased vitamin losses, the small and controlled amounts of ammonium bicarbonate used in this experiment were found to retain vitamins as well as water alone.

USE OF AMMONIUM BICARBONATE IN COMMERCIAL WATER BLANCHING OF FIVE GREEN VEGETABLES

Since an improvement in color was found in green beans when ammonium bicarbonate was used only in blanching, and since control of concentration of the additive would be easier to attain in a processing plant than in home or institutional cooking, an experiment was carried out to study the success of using ammonium bicarbonate in water blanching five green vegetables. The effect on color and other quality factors of cooked frozen peas, green beans, broccoli, brussels sprouts and lima beans was studied when three concentrations of ammonium bicarbonate were used in blanch waters.

The results showed that each concentration of ammonium bicarbonate markedly improved the color of all the vegetables except lima beans, as determined instrumentally and by a panel of judges. The judges did not find flavor adversely affected by the ammonium bicarbonate except for peas. Vegetables blanched in the higher concentrations of the compound were judged too soft in texture, but not those blanched at the lower concentrations. Overall eating quality was not adversely affected by ammonium bicarbonate and in the case of green beans and broccoli it was considerably improved. In no instance did ammonium bicarbonate increase losses of vitamin C and, brussels sprouts blanched in ammonium bicarbonate were higher in vitamin C than those blanched in water.

STEAM BLANCHING BROCCOLI WITH AMMONIUM BICARBONATE

Steam and water blanching prior to freezing vegetables have been compared by many research workers. In general, water blanching has been found to give better color and flavor in green vegetables, but higher losses of soluble nutrients. For numerous reasons, processing plants prefer water over steam blanching. However, the food industry is presently becoming aware of the contribution of blanch waters to water pollution. Therefore, there is now a renewed interest in steam blanching. Since ammonium bicarbonate differs from other common alkaline substances in that it breaks down during heating to form an alkaline gas, the use of this substance to improve color of steam blanched green vegetables was considered feasible. Currently, a research study is under way to compare water, steam and steam plus ammonium bicarbonate-blanched broccoli for color and nutrient retention and the blanching solutions for amounts of soluble substances leached into them which would contribute to pollution. Although the experiment has not yet been completed, results so far tend to show that the broccoli steam blanched with or without ammonium bicarbonate retains more minerals and vitamin C than the water blanched broccoli. Minerals and other solids appear to be greatly reduced in the waste water from steam blanch methods when compared to that from water blanching which would in turn decrease the contribution processing plants make to stream pollution.

USE OF AMMONIUM BICARBONATE IN HOME AND INSTITUTIONAL COOKING OF FRESH AND FROZEN GREEN VEGETABLES

Since the first experiment on green beans proved that color and quality of the vegetable was improved by using ammonium bicarbonate in cooking the water blanched vegetable, further study on home and institutional cooking of several fresh and frozen vegetables was thought to be of interest. Housewives have used baking soda for years to improve color of cooked green vegetables. Since it is difficult with kitchen equipment to measure the small amounts needed for improvement of color without adverse effects on vitamins, this experiment was undertaken to assess the optimum amounts to be used in cooking different vegetables. These amounts would be considered in making a tablet or capsule which could be added to the water in home or institutional cooking.

Fresh green beans, brussels sprouts, cabbage, broccoli and kale (purchased from the retail market) were cooked in household amounts. Those cooked with ammonium bicarbonate were found to be greener and as high in vitam C as those cooked in water.

Market packages (4 serving size) of frozen green beans, brussels sprouts and broccoli were cooked with ammonium bicarbonate and a calcium salt. The calcium salt was added in an effort to prevent the softening effect of ammonium bicarbonate noted in the above studies. In all cases, the frozen vegetables cooked with ammonium bicarbonate and the calcium salt were greener than those cooked in water. The use of the calcium salt prevented the adverse softening of the vegetables during cooking. Again, no adverse effects on vitamin C were noted.

Use of ammonium bicarbonate in steaming peas, spinach and broccoli for school lunches was found to improve the color of the vegetables after cooking and after holding on the serving line. Neither texture nor vitamins B_1 and C were adversely affected by the use of ammonium bicarbonate. Fifth-grade students preferred the ammonium bicarbonate steamed vegetables over those steamed without ammonium bicarbonate for color, taste and overall eating quality.

SUMMARY

The use of dilute solutions of ammonium bicarbonate for blanching and/or cooking green vegetables has been studied to determine whether or not this harmless compound would improve the quality, especially color of the vegetables studied.

The results of several studies show that the stability of the green color (chlorophyll) is improved by ammonium bicarbonate, either when used during blanching prior to freezing vegetables or during cooking either fresh or frozen green vegetables. Off-flavor was not found to be a problem, but excessive softening of the vegetable when higher concentrations were used was found to be a problem. The addition of a calcium salt corrected this problem.

The use of ammonium bicarbonate which, unlike baking soda, breaks down to form a gaseous alkaline substance, was found to be effective in improving the color of vegetables during steam blanching and during institutional cooking in a stack steamer. School children preferred vegetables steamed with ammonium bicarbonate, which were still greener after holding on the serving line, to those cooked without the compound. The use of steam, instead of water blanching, was found to decrease the solids in the waste waters which contribute to stream pollution.

In none of the experiments were vitamin losses increased by use of ammonium bicarbonate. Ammonium bicarbonate, possibly combined with a calcium salt, could be marketed as a tablet or capsule. It must be pointed out that strict control of amounts used are improtant for optimum quality of the vegetable. Although this compound is presently recognized as safe by the Food and Drug Administration, it would need the approval of this agency before marketing.

Project No. Y-6

UTILIZATION OF PEANUT FLOUR EQUALIZED TO THE FAO PATTERN BY YOUNG WOMEN

Although peanut protein has been studied rather extensively in animals, very few human studies investigating its nutritive value have been reported. Two groups of research workers in 1962 and 1965 demonstrated that nitrogen retention was greater in women receiving crystalline amino acids in the peanut pattern than crystalline amino acids in the FAO pattern. However, all the indespensible amino acids were furnished in larger amounts in the peanut pattern except the "limiting" amino acids, cystine and methionine, than in the FAO pattern, which probably accounted for the superiority of the peanut pattern over the FAO pattern. When these same workers were fed the intact protein in the form of peanut butter alone, or peanut butter supplemented with amino acids, to equal the FAO pattern, nitrogen retention was slightly better than crystalline amino acids in the FAO pattern. The higher nitrogen retention was attributed to the superiority of intact protein compared to crystalline amino acids. The Food and Agricultural Organization of the United Nations proposed what was considered an ideal FAO essential amino acid pattern for the adult human in 1957 based upon a large number of human research studies on the requirements of the essential amino acids.

The purpose of this human study was to determine the nutritive value of peanut flour compared to a 5:1 casein-lactalbumin mixture, when both these proteins were supplemented with pure crystalline essential amino acids equal to the FAO provisional pattern. Nonessential amino acids in the bovine milk pattern were used to provide nonessential amino acid nitrogen. These two diets of protein plus amino acid mixtures will be referred to as the casein-lactalbumin control diet and the peanut flour test diet. Recent research studies in the Northeast Region Agricultural Experiment Stations demonstrated that casein-lactalbumin supplemented with crystalline amino acids to the FAO pattern was equal to or better utilized by humans than crystalline amino acids in the FAO pattern.

Twelve college women, 17 to 20 years of age, volunteered as subjects and ten completed the experiment. The average weight of the ten subjects was 59 kg and average age, 19 years, which is very similar to the reference women used by the National Research Council. Each subject received 0.064 gm of nitrogen per kg body weight. Their body weight was kept constant throughout the study by weighing each subject daily and adjusting the individual calorie intake as required with cornstarch wafers and candy. All subjects received a multivitamin supplement and a mineral mixture. During the 7-day preliminary period, diets of ordinary foods typical of the American diet supplied 1.77 gm of nitrogen. Beef provided the remaining additional nitrogen.

A cross-over experimental design was used for the 20-day experimental period. Subjects were randomly divided into two groups. During the first 10-days, half of the group was given the peanut flour test diet while the other half was given the casein-lactalbumin control diet. The proteins were reversed for the second 10-days. During the experimental period, a low protein basal diet consisted mainly of fruits, fruit juices, sugar, cornstarch and fat. These diets were very low in protein supplying 0.59 g of nitrogen which was considered as nonessential amino acid nitrogen. Casein-lactalbumin provided 49.8% and peanut flour 66.5% of the intact protein nitrogen. Subjects consumed the amino acids in fruit juices. The defatted peanut flour and casein-lactalbumin were not incorporated into foods, but were consumed in fruit juice or mixed with fat and spread on cornstarch wafers as desired by the individual.

Daily 24-hour urine and fecal excretions were collected. Carmine fecal markers were given at the beginning and end of the preliminary period and on every fifth day of the experimental period. Five day fecal composites were prepared based on the carmine markers. Daily food composites were prepared. Total nitrogen was determined on urine, fecal composites and food samples. Daily creatinine analysis of urine were checked on the completeness of the 24-hour collection. Urinary urea and ammonia nitrogen were determined. Only the second 5-days of each 10-day period were used in the study. They were considered more indicative of the utilization of nitrogen from the test diet, since any carry-over effect from the preliminary period would be minimized.

The total average nitrogen intake of the 10 subjects was 3.79 g per day or 23.69 g of protein per day. At this nitrogen intake, the nitrogen balance was positive for all subjects regardless of the protein source. However, a significantly higher nitrogen retention of 0.82 g was attained by feeding the casein-lactalbumin control diet compared to 0.18 g of nitrogen on the peanut flour test diet. Urea nitrogen was not significantly different for the two diets. Although the excretion of ammonia nitrogen was higher on the peanut flour test diet, 0.35 g, than on the casein-lactalbumin control diet, 0.28 g, the levels were not significantly different due to the wide individual variation.

The results of this study indicate an impaired utilization of nitrogen in the peanut flour test diet compared to the casein-lactalbumin diet as evidenced by nitrogen balance. Yet, the peanut flour test diet was capable of maintaining a positive nitrogen balance in women at a very low level of nitrogen intake. The nitrogen balance data showed that the digestion and absorption of nitrogen in peanut flour was not impaired, but these data do not reveal the effect on individual amino acids. The trend to a higher amonia production on the peanut flour test diet suggests that protein synthesis may have been limited by the diversion of amino acids to ammonia production for the purpose of maintaining acid-base balance. This trend to a higher ammonia production on the peanut flour test diet could be due to faulty digestion, absorption or intermediary metabolism of a specific amino acid with an increase in an unbalanced pattern of amino acids in the tissue, resulting in an increased ammonia excretion. Several other groups of research workers have reported increased urinary ammonia excretion resulted from crystalline amino acid diets. However, the peanut flour test diet supplied one-third crystalline amino acid nitrogen, whereas the casein-lactalbumin control diet supplied one-half. This study demonstrates that proteins do not have comparable nutritive values when they have comparable essential amino acid levels achieved by means of crystalline amino acid supplementation. Moreover, a greater amount of intact protein nitrogen, as compared to crystalline amino acid nitrogen, does not necessarily result in a superior nutritive value.

Although the FAO essential amino acid pattern was used for test purposes, it may not represent the ideal amino acid pattern for man. Various research workers found that for man the milk and whole egg patterns were better than, or equal to, comparable levels of the FAO pattern regardless of whether amino acids were furnished in a purified form or by intact food protein.

In this study, casein-lactalbumin supplemented to the FAO pattern was employed as the control diet, because it was shown to be equal to, or better utilized in humans than crystalline amino acids in the FAO pattern by the Northeast Region Experiment Stations. This study in women was performed under experimental conditions as similar as possible to those of the Vermont Experiment Station, which used young men as subjects. The nitrogen balance was positive in the 10 young women in this study consuming the casein-lactalbumin control diet, but slightly negative in the eight young men at the Vermont Experiment Station. The difference in nitrogen balance of the men and women suggests that there may be a higher minimum protein requirement for men than women per kg. body weight. Other human studies have demonstrated that the total essential nitrogen requirement for young women was not as great as for young men. This difference in the total essential nitrogen balance found in young women reported in this study and in young men studied in Vermont.

This project was terminated in December, 1970.

COPPER METABOLISM AND RECOMMENDED COPPER ALLOWANCE FOR WOMEN

The minimum daily copper requirement for the adult human has been reported by three different groups of workers in China, India and the United States to be 2.0 mg per day. Copper balance studies at various levels of copper intake were employed as the basis of the requirement. Irrespective of the climate, sex and widely different diets consumed, their findings of the minimum requirement were identical. Menstrual losses and sweat losses were not included nor considered in the requirement. Menstrual copper losses range from 0.19 to 0.72 mg per period. Sweat losses under hot climatic conditions are as high as 1.9 mg per day. Under moderate climatic conditions, sweat losses in the magnitude of 0.05 to 0.07 mg per day occur.

Moreover, a fair number of subjects in the six copper balance studies published to date were unable to meet their copper requirement on intakes above the minimum requirement ranging from 2.04 mg to 3.69 mg per day.

The current study was designed to investigate the utilization of proteins. It provided an opportunity to study the apparent absorption and retention of copper in young women consuming an animal protein, casein-lactalbumin and a plant protein, peanut flour. No attempt was made to arrive at a uniform intake of copper for all subjects. The proteins were supplemented with crystalline essential amino acids to the FAO pattern and with crystalline nonessential amino acids in the bovine milk pattern. Protein was fed at 0.4 g per kg body weight. The copper intakes in this study were considerably higher than the minimum requirement, hence, they were expected to maintain all subjects in equilibrium or moderately positive balance.

The subjects were 10 college women, 17 to 20 years of age attending university classes. Sweat losses could not be determined under these conditions. A 7-day preliminary period and two 10-day experimental periods employing a cross-over experimental design were used. The preliminary period provided typical American menus and equalized the nutritional status of the group. Distilled water was used for cooking and drinking, and glass vessels were employed for cooking. The two menus, A and B, during the experimental period provided mainly fruits, fruit juices, fruit preserves; cornstarch in puddings, cookies and biscuits; sucrose and glucose in candies; and hydrogenated vegetable oil. A mineral mix provided 2.372 mg of copper, consumed in two doses. A multivitamin supplement was provided daily.

Atomic absorption spectrophotometry was employed to determine the copper content of the mineral mix, proteins, and food consumed, as well as the excreted copper in urine and feces. The total 10-day experimental period was studied. Only the last 5-days of the experimental periods are presented; the first 5-days were considered an adjustment period to the different levels of copper intake. The experimental error on duplicates of food, feces and mineral mix was ± 5 percent and for urine ± 20 percent or less.

A significantly higher average copper intake of 4.36 ± 0.082 mg for subjects consuming the peanut flour diet was due to the higher copper contribution of peanut flour. The casein-lactalbumin diet provided an average intake of 3.90 ± 0.051 mg of copper per day.

The average urinary, fecal, retention and percent apparent absorption was 1.17, 2.11, +1.79 mg and 45.96 percent respectively on casein-lactalbumin. The corresponding values for peanut flour were 1.09, 2.62, +1.73 mg and 40.0 percent, respectively. No significant differences were evident. However, the higher average fecal copper and lower percent absorption of the group consuming peanut flour were significant at the 0.10 level of probability. The lower apparent absorption on the peanut flour diet may have been due to its rather high content of phytic acid which is absent in casein-lactalbumin.

The order of feeding proteins had no significant influence on the group mean copper retention and percent apparent absorption. Urinary copper values were very low and had a negligible effect on copper balances.

Menstrual copper losses occurred in only two subjects, subject 4 on casein-lactalbumin and subject 8 on peanut flour. Both had high average 5-day retentions of +2.68 mg and +2.80 mg, respectively. When correction for maximum menses losses of 0.72 mg per period and moderate sweat losses of 0.070 mg per day, were made these subjects continued to have high corrected retentions of 2.467 mg and 2.589 mg, respectively.

However, on the peanut flour diet subjects 6 and 9 had the lowest balances of +0.280 mg and +0.234 mg without correction for sweat losses. After correction for sweat losses, their balances would be +0.210 mg and 0.164 mg, respectively. These balances represent a state of equilibrium and not copper retention, because the experimental error on duplicate food and fecal samples is ± 5 percent. Therefore, equilibrium for subjects 6 and 9 would be balances in the range of ± 0.218 mg and ± 0.222 mg, respectively. If this investigation had been carried out under hot or warm climatic conditions, sweat losses of 1.0 mg or more would have occurred. In that event both subjects 6 and 9 would be in marked negative balances of -0.720 mg and -0.766 mg, respectively.

All subjects on the casein-lactalbumin diet are in positive copper balance after a moderate sweat loss correction of 0.070 mg. But, under hot climatic conditions, subjects 1 and 6 would be in negative copper balance.

Our results indicate that the copper allowance for young women should be in the range of 4.5 to 5.0 mg of copper daily in order to meet the needs of all healthy young women. This estimate allows a safety factor of 2.0 mg and an allowance of 0.5 to 1.0 mg for sweat and menstrual losses, depending upon the climatic conditions, added to the minimum requirement of 2.0 mg.
This study was terminated in December, 1971.

PROJECT REPORTS

POULTRY SCIENCE

DEPARTMENT OF POULTRY SCIENCE

INTRODUCTION

The poultry industry of Maryland continues to grow at about the same rate as the national average for the industry, and continues to be a major producer of agricultural income in the state. It is one of the most sophisticated agricultural industries in so far as it is highly organized, highly specialized, and applies scientific information quickly after publication. The continued increase in efficiency with which poultry products are produced attests to these observations. Research both of an applied and theoretical nature is carried on continuously, but both types of research are problem oriented. Farmers are being made more aware of pollution control problems. Some research is being directed in this area, and researchers are continuously striving to find more economical ways to feed birds, to prevent disease, and to process them into appetizing human food. As labor short-cuts are necessitated, often other unforeseen problems arise.

Research laboratories and field stations of the department are always open for inspection, and we are glad to discuss with interested parties current research data and proposed research projects.

EFFECTS OF GONADAL HORMONES ON EMBRYONIC AND POSTNATAL BONE GROWTH IN CHICKENS

This project is an attempt to determine the basic effect of the male and female sex hormones on the differences in body weight of birds of different sexes, and to determine the degree to which different hormone combinations affect one another. Several trials have been completed involving the use of the male sex hormone, testosterone propionate, and various female sex hormones in the growth and calcification of the long bones of embryos and growing chicks. One of the objectives is to determine whether or not treatment with synthetic hormones might conceivably improve body conformation without reducing rate of growth. A shortening of the long bones by slightly more than 15 percent has been accomplished without a reduction in body size.

Embryos have been treated with the male and female sex hormones to determine the effect of this treatment on the development of the right gonad of the female following the removal of the normal functioning left gonad. The results indicate that embryonic preconditioning with gonadal hormones does increase the normal development of the right ovatestis following removal of the left ovary. However, no fertile individuals have been produced to date. A female producing viable sperm after such a treatment would indeed be an interesting genetic tool to use in the study of traits of economic importance. This project was terminated December 31, 1972.

Project No. M-64

APPLIED BROILER NUTRITION STUDIES

Practical ways of reducing the cost of rearing broilers are constantly being sought. Reducing the amount of vitamins added to the feed during the withdrawal period (7-8½ weeks of age) has not adversely affected either weight gain or feed conversion.

In some areas of the country consumers prefer birds that have a well pigmented skin. Many factors influence the cost of producing a bird with a high degree of pigmentation. Recent experiments have shown that processing can influence the amount of pigment retained on the skin. As much as 30 percent can be lost during scalding. Both the length of time the birds are scalded and the temperature of the scald water have an influence on the color of the broilers.

Certain ingredients have more available xanthophyll than others. Both corn and corn gluten appear to have more available xanthophyll than the other ingredients that have been tested.

Project No. M-66

THE INHERITANCE OF LYSINE UTILIZATION

A study of the genetic control of the requirement for lysine has led to the conclusion that lysine requirements are definitely under genetic control. Japanese quail have been employed and selected for growth under dietary regimens that provided normal amounts of lysine (full diet) and regimens that provided minimal lysine (deficient diet). A line has been developed (D line) that grows, lives, hatches and produces eggs quite normally when provided only 65 to 70 percent of the normal lysine requirement. This has been accomplished after some 21 generations of selection. The birds are fed the deficient ration when between two-and-four weeks of age. A second line (F line) has been selected for growth on a ration considered to be adequate in lysine content. The performance of both has been compared to a random--bred control line.

Arginase is an enzyme found in the kidney of birds and is involved in some manner with the metabolism of amino acids. Birds of both the F and D lines are placed on full and deficient diets and kidney arginase activity and kidney weights are measured. No relationship has been found between arginase activity and kidney weight. Both arginase activity and kidney weight show an increase in both lines when they are fed the full diet. The F line birds have less arginase activity than the D line birds, regardless of the type of diet. Selection for decreased arginase activity in the F line is indicated by the fact that an increase of lysine in the ration does not increase arginase activity in the F line to the same magnitude as it does in the D line.

Random--bred quail fed a commercial turkey-starter ration were used to determine whether there was a relationship between weekly growth-rate and arginase activity. It is found that arginase activity in the kidney does not increase in a direct relationship to the increase in body weight. It is conclusive from all studies that increasing the level of lysine in the diet produces an increase in arginase activity, and that the enzyme arginase may be the physiological basis for genetic differences in lysine utilization. This project was discontinued December 31, 1972.

Project No. M-70

DAY LENGTH AND EGG PRODUCTION

Within the last decade there has been a marked change in the husbandry concerned with egg production, particularly poultry housing. Most of the pullets are now started in confinement houses where light can be easily regulated. Likewise, most egg-production houses, whether floor or cage operations, can be light controlled. The ability of the poultryman to alter the physical environment of the chicken prompts further investigations into the effect of different light regimes, including such diverse things as days of different lengths. Poultrymen for years have known of the stimulative effect of light on reproductive performance of birds. Controlled research, as well as trial-and-error, has indicated that usually optimum production is obtained when laying hens are exposed to 14 hours of light and 10 hours of dark per day. Many other combinations of light and dark within a 24-hour day have been investigated, but little work has involved days shorter or longer than the 24 hours. When pullets begin their first laying year, production often peaks at nearly 90 percent. Obviously little improvement over this figure could be expected by any treatment and the lengthening of the day to more than 24 hours would be expected to lower production because there would be fewer days or total light cycles per month. However, as the laying season progresses, production decreases, and a lag time of one-and-a-half to two-hours develops between the laying of each successive egg. This delay in laying causes the bird to eventually skip a whole day when no egg is laid and then start production all over again. This is referred to as the clutch of the bird. A day longer than the 24 hours at this time in the hen's production might minimize the number of days when no egg is laid. Employing, for example, a 26-hour day would reduce by one-twelfth the number of "days" per month, yet if the hen laid at a significantly higher rate per "day" the procedure might well be economically beneficial.

To study this problem, a series of 12 small laying pens with a capacity of 25 birds each has been employed. Within these facilities three different light regimes were employed in the preliminary study. One group was subjected to the normal 24-hour day with 14 hours of light and 10 hours of dark. Two other groups were given 26-hour days, one with 16 hours of light and 10 hours of dark, another with 14 hours of light and 12 hours of dark. We were thus able to study the effect of increasing light as well as increasing day length. The first year's experience with pullets indicated that the longer days decreased somewhat the production during the early part of the laying year with the end results that all three light regimes produced about the same total number of eggs per hen housed. There was no marked difference in egg size, shell thickness, mortality or feed consumption.

As the year progressed the longer days appeared to exert a beneficial effect, hence a current project is under way to investigate the effect of 26-hour days in the second year of egg production. The effect of this treatment on the egg production of broiler breeders will be investigated in the future. Broiler breeders are rather notorious for their relatively poor total egg production.

Project No. M-72

STUDIES OF THE INFLUENCE OF SLUSH–ICE CHILLING AND CARCASS WATER CONTENT ON THE QUALITY OF PROCESSED POULTRY

The variation in changes in weight between individual carcasses chilled in slush-ice has been so large that it masks treatment effects. Efforts to control the variation have proven to be fruitless. Therefore, attempts to measure the influence of ice particle size, weight of storage ice/unit of carcass weight, and carcass position in the shipping container on carcass weight changes in storage have been unsuccessful. This project was terminated December 31, 1970.

Project No. M-101

STUDIES OF FACTORS INFLUENCING BROILER YIELDS, AND MICROFLORA OF PROCESSED BROILERS

Poultry processors are concerned about the quality of broilers that consumers place on their tables. Two factors that contribute to the overall quality of broilers are meat yields and microbial wholesomeness. It is the purpose of this project to study how the strain of broiler influences the yield of parts from a carcass. Also, how does light energy affect microorganisms on the surface of processed chicken.

Results are that different strains of broilers will produce significantly different percentage yields of breasts, drumsticks, wings and back based on their chilled-carcass weights. However, when strains are tested within equal carcass weight-groups, there are no differences in the percent yield of the various parts. This indicates that the strain influence is a matter of different growthrates of the strains tested.

Another study has been conducted to consider the photo-sensitivity of microorganisms as a means of controlling spoilage of processed poultry. Carcasses are treated with dyes which make some microorganisms sensitive to light rays. The carcasses are divided into two groups, one refrigerated in the dark, the other exposed to light. No significant increases in shelf-life of the poultry have been observed. However, trials using heat lamps and organic acid pasteurization did give some improved shelf-life compared to an untreated control. This project was terminated December 31, 1971.

Project No. M-102

STUDIES OF THE YOLK AND VITELLINE MEMBRANE OF THE EGG AS THEY INFLUENCE EGG QUALITY

The purpose of this work is to study the vitelline membrane and albumen of the hens egg and to determine their influence on egg quality. As the egg ages under normal storage conditions, the functional quality decreases. The cause of this decrease in quality has been attributed to such things as a loss of water, changes in protein structure, increase in CO^2, etc. It has also been determined that if the vitelline membrane ruptures and the yolk contents become mixed with the albumen, the functional properties decrease in proportion to the amount of yolk that becomes mixed. As the age of the egg increases, the vitelline membrane deteriorates and becomes more easily ruptured.

Initial experimentation has been directed toward developing techniques that allow study of the vitelline membrane and its relationship to the yolk and albumen it separates. These techniques have been developed and the characteristics of this membrane are under study. It has also been determined that the lipid constituents of the yolk and albumen vary during storage and the chain length and degree of saturation of the lipid influences the migration across the membrane. Research is continuing in an effort to learn more about this mechanism in order that the storage quality of egg and egg products can be increased.

Project No. M-103

MICROBIAL ASSESSMENT AND REDUCTION STUDIES FOR PROCESSED AND FURTHER PROCESSED BROILERS

During the processing of broilers, carcasses are released from the kill line shackles to a transfer-belt after the scald, pick and shank removal operation. The carcasses are then manually hung on the evisceration line. The number of carcasses on the belt at one time is dependent upon sychronization of the kill and evisceration lines. Because of the potential of accelerated microbial contamination of carcasses, a study has been conducted to evaluate cleanup adequacy and ascendency of coliform and total-count organisms on the belts during processing. Belt swabs have been taken prior to start of processing at first-break, and at noon-break. The results show that the degree of cleanliness of the transfer-belt is a valid criteria for evaluation of cleanup. There is little day-to-day variation in total or coliform counts of the three belts used for transfer. Without a spray wash on each continually moving belt, there is a rapid ascendency of organisms. Spraying of the belts reduces the buildup of organisms. The use of chlorine in the spray water is most effective in keeping counts low throughout processing.

When a shank is removed below the hock-joint by the automatic hock cutter, a condition referred to as short-hock exists. The condyle (knob) is severed off leaving the sheath and meat exposed. When such a condition exists, the government requires that the drumstick portion of the leg be condemned due to possible contamination. A study is underway to measure microbial differences between drumsticks with and without the short-hock condition. Meat from the portion opposite the condyle end of the drumstick and next to the bone is aseptically removed and plated for total, coliform, *Salmonella,* and *Staphylococcus* counts. Short-hock drumsticks appear to possess higher coliform and total counts. Counts on all drumsticks are found to be related to the counts on the transfer-belt during the experiment. The results reiterate the need for keeping transfer-belts clean during processing. In addition, *Salmonella* is not found on either type of drumstick and *Staphylococcus* counts have ranged from one to nine organisms, when found. The results indicate that a pathogenic condition does not exist with short-hock drumsticks and that the meat could be salvaged for further processing.

Project No. M-104

LIGHT INFLUENCE UPON PROCESSING FACTORS OF BROILERS REARED IN WINDOWLESS HOUSES – LUMINOSITY AND WAVELENGTH

Two studies have been initiated to measure the influence of different light regimes under windowless house conditions. One study measures the influence of four light intensities (0.25, 0.5, 1.0, and 2.0 foot-candles) utilizing incandescent bulbs. The second study involves the use of colored, fluorescent lamps (ultra-violet, blue, yellow, and red) as light sources. Both studies have been conducted in the Environmental House at the University of Maryland Broiler Substation. Some of the birds were reared under natural daylight conditions for comparison.

In the light intensity study, the following trends have been found:

(1) Broilers reared in windowless pens have had higher average eviscerated yields than broilers reared under natural daylight conditions.
(2) Giblet and neck yields have not been different between treatments.
(3) Broilers reared in the 1.0 and 2.0 foot-candle regimes have had slightly better fleshing, as measured by breast angle, than broilers reared under natural daylight.
(4) Average score for visual skin color has not shown any differences, but the xanthophyll pigment extracted from the skin has been slightly higher for the light intensity treatments, when compared to the natural daylight treatment.
(5) Average breast blister size has not been different between treatments and average percent trimmed blisters are lower for broilers reared in pens under the four intensities of artificial light.
(6) Condemnation averages are lower for the 0.25, 0.5 and 1.0 foot-candle treatments, when compared to the natural daylight and 2.0 foot-candle treatments.

In the fluorescent lamp study, the following has been found:

(1) There are no differences between treatments for eviscerated, giblet and neck-yields.
(2) Broilers reared under the red lamps have better fleshing than broilers reared under natural daylight.
(3) Average visual skin-color scores have shown little differences, and the average xanthophyll pigment content of skins from broilers reared under red lamps is higher than the pigment content from broilers reared under natural daylight.
(4) Average breast blister size has not been different between treatments. Percent trimmed blisters are lower for the ultra-violet, blue and red lamp treatments, when compared to the yellow lamp and natural daylight treatments.
(5) A higher average rate of condemnations has been found for the ultra-violet lamp treatment.

Project No. M-105

AMMONIA INTOXICATION IN THE FOWL AND ITS INFLUENCE ON METABOLIC PROCESSES

Ammonia is a natural by-product of bacterial action on fecal and urinary waste materials. Exposure of birds to this substance, in concentrations too low for man to detect by smell for prolonged periods of time, may result in harmful effects on both broilers and laying hens. Among these harmful effects are susceptibility to respiratory disease, blindness, decreased feed consumption, impaired feed conversion and depressed growth and rate-of-lay. These depressions in performance would increase the cost per bird and could mean the difference between a profit or loss in many poultry operations. Studies on ammonia intoxication of chicks suggest that ammonia may function to alter protein metabolism.

A study is underway to determine whether or not ammonia intoxication in poultry does alter protein metabolism and to determine what mechanism or mechanisms may be involved. If these can be determined, it may be possible to develop some program to aid the producer in rectifying this problem, and thus enable him to improve the quality of his product.

Project No. M-106

USE OF CHICK BIO–ASSAY IN MEASURING SPECIFIC AMINO ACID AVAILABILITY

One of the major problems in poultry nutrition is to determine the amount of a particular amino acid that is biologically available in a feedstuff. Since animals and birds digest proteins with enzymes, it is possible that the amount of a particular amino acid they are able to free from a protein is different from the amount that can be obtained from a chemical analysis.

The available lysine content of a large number of ingredients has been determined. The values are as follows: anchovy fish meal 4.41 percent, menhaden fish meal 4.42 percent, Canadian herring fish meal 5.45 percent, poultry by-products meal 2.13 percent, soybean meal 3.09 percent corn meal 0.26 percent, and dried bakery product 0.18 percent.

Similarly values for available methionine have also been determined. They are anchovy fish meal 2.11 percent, menhaden fish meal 2.08 percent, soybean meal 0.71 percent, canadian hearing fish meal 2.45 percent, poultry by-products meal 1.12 percent.and corn meal 0.21 percent.

Project No. M-208

EFFECT OF PROTEIN LEVEL AND AMINO ACID BALANCE ON VOLUNTARY FOOD CONSUMPTION

The parent stock of commercial broilers grow rapidly and attain a large size. They consume large amounts of feed but are not good layers. The cost of maintaining these birds is high and ways and means of lowering the cost of production of broiler type chicks is constantly being sought. One of the methods to reduce the cost of maintaining these broiler breeds is to limit the amount of feed they can consume.

In a study that has been completed, the effect of feeding an amino acid imbalanced grower diet on subsequent production has been measured. Little difference in weight at 20 weeks of age has been found, probably as a result of the imbalanced diet not being sufficiently deficient in the amino acid given.

The results have shown that during the laying period it is possible to reduce the amount of weight the birds will gain by restricting the amount of energy the birds consume. This can be accomplished by restricting the birds to one feeding period or two shorter ones. This method did not significantly reduce egg production.

An attempt has been made to feed laying strain birds a diet which has been diluted with clay. The effect has been to increase voluntary feed consumption with a slight increase in over-all production.

Project No. M-209

DETERMINATION OF AMINO ACID REQUIREMENTS OF GROWING BROILER CHICKS AND LAYING HENS

Recent nutrition research has been directed to increase our knowledge about the nutritional requirements of broilers and to see how we can reduce the cost of raising the birds.

Proteins are made up of amino acids, some of which are more important than others from a nutritional point of view. The amino acid lysine is one of the most important in broiler nutrition. Not all of the lysine found in some feedstuffs is readily available to the birds.

With the information that is available on "available" lysine, it is now possible to determine more accurately how much lysine broilers need for growth. This knowledge will help to reduce the cost of growing broilers, because lysine is often a "pressure point" in least cost formulation. This means the ration has no excess of this nutrient. If the requirement was lowered, then the over-all cost would be less. Recent work has shown that the lysine requirement for the withdrawal period (7-8½ weeks of age) is approximately 20 percent lower than originally suggested.

Since protein supplements have become very costly recently, the addition of excess protein to meet broiler chick needs for essential amino acids has undergone re-evaluation. Sulfur amino acids such as methionine are known to be limiting in broiler rations and efforts are in progress to reduce the amount of protein needed to meet these requirements and to reduce the amount of methionine or methionine analogue required to meet recommended nutrient standards.

Inorganic sulfates such as the sodium, potassium or ammonium salts have been tested to date. All three appear equally efficacious in broiler diets. Economically, the potassium and sodium salts are the most practical inorganic sulfur sources. Our studies show that at least six percent of the total sulfur commonly used in broiler rations can be supplied as inorganic sulfate. Studies also indicate that inorganic sulfate, although able to be used effectively by the chick for several specific metabolic functions, is not a dietary essential *per se.*

Project No. M-210

INCREASING THE EFFICIENCY OF ENERGY METABOLISM IN FOWL

Some years ago a method was developed for determining the yield of energy from metabolism of compounds in the body. This procedure will permit one to estimate, for example, the number of calories needed to synthesize urea, uric acid and ammonia, the end products of nitrogen metabolism in birds. If the energy requirement is appreciable, it may be desirable to restrict the nitrogen in the diet (protein, amino acids) to the minimum needed for maximum growth. If the energy cost is trivial, no such restriction should be applied, thus allowing the computer more latitude in formulation of the diet. Of course, any theoretical approach such as this should always be checked by feeding trials.

Meaningful progress proved to be very difficult. This project was terminated December 31, 1972.

Project No. M-211

NUTRITION IMPROVEMENT IN THE NORTHEAST REGION

A protein crisis exists in all parts of the world today, including the Northeast region of the United States. In several countries, the food protein shortage is so acute that protein deficiency (Kwashiorkor disease) is rampant in large numbers of the child population. Protein deficiency is not demostrated by such an extreme nutritional disorder in our country; however, marginal protein deficiency does occur. In addition, the food protein shortage in the U. S. is expressed as rapidly-rising meat prices.

The children in families that earn a marginal income may suffer marginal protein deficiency. Children require a higher rate of good quality protein than the adult population. A borderline deficiency of good guality protein in children results in poor muscle and other tissue growth.

Improved methods of amino acid (protein building bloch's) analysis have made it possible for plant geneticists to produce cereals and legumes with better quality protein composition. Chemical analyses of these new varieties of corn, oats, barley, buckwheat and soybeans show that their essential amino acid content has been increased. Nutritional studies with experimental animals and then with the human have shown that these new plant protein foods can adequately support the protein requirements of growing animals and children.

This research points to the production of lower cost protein animal feed concentrates. These concentrates are necessary to assure a low cost animal protein food, such as broiler meat, for human consumption.

Project No. M-212 (NE-73)

INTERRELATIONSHIP OF SELENIUM AND CYSTINE WITH MERCURY

Several studies with laying hens and Japanese quail (Coturnix corturnix japonica) have shown that methyl mercuric chloride toxicity can be reduced or temporarily prevented by low levels of supplementary selenium and/or therapuetic levels of vitamin E.

However, levels (500 I.U./kg diet) of vitamin E alone appear to have a toxic effect on quail and further studies are in progress. Work is also currently in progress to determine whether or not the rehabilitative effects of vitamin E is due to a sparing effect on selenium or whether it is a particular property of vitamin E itself.

Project No. M-213

SELECTION FOR VIABILITY OF BROILER BREEDING STOCK

In spite of the excellent environment and high nutrition that is provided to our broiler growing stock, some mortality still results and there is some downgrading in broilers. One of the major causes for downgrading is the presence of breast blisters. This study was initiated to determine the feasibility of genetically combining high viability and good carcass quality with other traits important to the broilerman, particularly rapid rate of growth. The study is being conducted at the Salisbury broiler substation. A synthetic line has been developed from crosses of commercially available birds. The selection is currently in the fifth generation. A total of 26 male pens are being utilized to produce each generation of pedigreed chicks and a double shift of males is employed, thus testing a total of 52 sire families. Selection is based on relative livability, growth and over-all vitality of the birds as determined by individual phenotypes; that is, freedom from physical defects, particularly leg weakness and breast blisters. One problem that continues to plague the project is the fact that the females of this strain fail to use the nests for egg laying. This prevents identifying the chicks by dam as well as sire and results in somewhat lower hatchability because many of the eggs are soiled and dirty.

Particular emphasis is being applied to the relationship between breast ridge, comb type and breast blisters since breast blisters are one of the major causes of downgrading in the processing plant. An improvement in these traits must not be at the expense of rapid rate of growth, since growth rate is unalterably tied to efficiency of production. Economics dictates that improvement in other traits cannot be at the expense of growth.

The current generations are being reared in wire cages with wire floors for the first eight weeks to increase the selection pressure for resistance to breast blisters, because evidence is accumulating that broilers may soon be grown in wire batteries. At the end of this period, they are scored for breast blisters, weighed and selected individuals are then transferred to floor pens for rearing. Preliminary results after three generations of such selection indicate that genetic resistance to breast blisters can be greatly increased by this technique.

Project No. M-304

GENETIC BASES FOR RESISTANCE TO LEUKOSIS IN THE FOWL

The avian leukosis complex still accounts for a substantial loss to the poultry industry due to deaths and meat condemnation, even with the advent of the development of the herpes turkey virus vaccine for the control of Marek's disease.

Work has progressed to select two lines of birds exhibiting high and low serum cathepsin levels in an effort to correlate the activity of this enzyme to resistance and/or susceptibility to the avian leukosis complex. Selection has resulted in significant differences between lines with respect to six-week serum cathepsin levels. No significant differences are observed in levels between sexes within the lines, however, male levels are consistently higher than female levels at this age.

Performance data accumulated to date indicate that there are no statistical differences in any of the performance criteria tested except six-week body weight, which is significantly depressed in the selected lines, with the high line having a greater weight depression than the low line. Mortality data indicate greater susceptibility in the high line to deaths from all causes, including Marek's disease. No significant mortality differences exist between the low cathepsin line and the randombred controls.

Embryonated eggs from the high line, low line and the randombred controls have been tested by the chorioallantoic membrane assay for resistance to Rous sarcoma virus Subgroups A, B and C. The Rous sarcoma virus is one which has properties similar to the lymphoid leukosis virus, but grows much faster than the lymphoid leukosis virus. Therefore, it is the virus of choice for a fast assay to determine possible resistance to lymphoid leukosis. Statistical analyses of data obtained from this assay indicate a slight degree of resistance in the high line to Subgroups A and C. These data also indicate that selection may have imparted an increase in susceptibility of the low line to Subgroup C. Line selection appears to have had no influence on either susceptibility or resistance to Subgroup B, in that all lines demonstrated resistance to this virus. In addition, chicks from all three lines have been hatched and inoculated with a strain of Marek's disease virus. While mortality and tumor formation are greater in the inoculated groups than in the uninoculated controls, no difference is observed in mortality or tumor formation within the inoculated groups.

Project No. M-305 (NE-60)

PROJECT REPORTS

VETERINARY SCIENCE

VETERINARY SCIENCE

ETIOLOGY AND CONTROL OF AVIAN LEUKOSIS

Live chicks, embryonated chicken eggs, primary chicken kidney and duck embryo fibroblast (DEF) cell cultures were compared for their sensitivity in detecting Marek's Disease herpes virus (MDHV). DEF cell cultures were found more sensitive for detection of MDHV than the other methods when infection was determined by culture of kidneys or by use of a radial diffusion (RD) test for MDHV feather follicle antigen at 14 days post-inoculation (PI). At 21 days PI, chicks appeared as sensitive as DEF cultures when infection was determined by kidney culture and more sensitive when the RD test was used to determine infected birds.

Specific fluorescent antibody (FA) conjugates were prepared in rabbits and chickens for detecting MDHV in cell cultures. FA conjugates from convalescent serum of infected chickens were superior to hyperimmune rabbit serum for MDHV detection.

No relationship of chicken syncytial virus to Marek's Disease (MD) was found.

A modified direct complement-fixation (CF) test was developed to detect MD antibodies in chicken serum. Qualitative differences in MD antibodies were found by CF and an agar gel precipitin (AGP) test. CF antibodies appear later than AGP antibodies.

A simple and rapid qualitative radial immunodiffusion (RID) test was developed which detects antigen(s) in the feather tips of chickens infected with MDHV. Antiserum, which is incorporated into a support medium, reacts with the antigen(s) in the feather tip producing a radial precipitin ring. Antigen(s) was detected in 93.3 percent of inoculated chickens 21 days PI and in 100 percent of infected birds tested subsequently through six weeks. Feathers from uninoculated controls gave no reaction. Positive tests could be detected after one to two hours of incubation. Antigen detection by RID correlated well with other criteria of infection; namely, paralysis, gross lesions at necropsy, virus isolation and FA tests on skin samples. This test should be very useful in both diagnostic and research laboratories.

Project No. D-68

FLUORESCENT ANTIBODY TECHNIQUE IN RESPIRATORY DISEASES OF POULTRY

Considerable economic losses to the poultry industry are brought about by respiratory diseases caused by Mycoplasma and viruses. The fluorescent antibody (FA) test has been used as a serological adjunct to identify 370 mycoplasma field isolates. Comparative FA and culture isolation tests were made on 279 cases. There was agreement in 85 percent of the cases. Each method detected about 7.5 percent Mycoplasma where the opposite method failed. This demonstrates the value of using complementary tests should one be negative.

The direct FA method of typing Mycoplasma isolates with culture sediment proved unsatisfactory.

The direct FA was also used to examine 732 samples for the viruses of Newcastle Disease (ND), Infectious Bronchitis (IB) and Laryngotracheitis (LT). Positive samples ranged from 5.5 - 17.3 percent for ND; 29 to 49 percent for IB, and 10.4 - 27 percent for LT. Total samples positive for respiratory viruses ranged from 61.5 - 76 percent. This indicates a significant contribution by these viruses to the respiratory disease problem.

Virus isolation and FA comparative tests ranged in agreement from 69.1 - 74.1 percent. A significant number of samples were positive by virus isolation and negative by FA, but the converse was also true. This indicates both techniques should be utilized to identify an etiological agent since each test complements the other.

It was also found that present FA conjugated antisera are not capable of differentiating strains of Infectious Bronchitis virus.

Project No. D-59

RESPIRATORY DISEASES OF POULTRY

Respiratory diseases of poultry have been responsible for considerable economic losses to the industry. A direct complement-fixation test was developed to detect antibodies to *Mycoplasma gallisepticum* (MG) in chicken serum. This test correlated well with the MG serum plate and hemagglutination-inhibition tests. Little cross-reactivity between MG and *Mycoplasma synoviae* was encounted with the CF test.

Serological surveillance has shown that MG infections still persist in poultry operations.

Project No. D-52

TECHNIQUES FOR ERADICATING INFECTIOUS DISEASES OF POULTRY

Serology and culture techniques were used to ascertain the status of Mycoplasma suspect samples. Significant numbers of *Mycoplasma synoviae* (MS) isolations, ranging from 12.9 percent to 21.8 percent were made. These were from 516 and 101 isolation attempts respectively. *Mycoplasma gallisepticum* isolations ranged from 2.1 percent of 522 attempts to 3 percent of 299 attempts.

Serological surveys were performed for MS antibodies on 27,270 samples from 217 flocks. The reactor rate ranged from 11.5 percent to 40 percent. Similar surveys for MG antibodies on 208,829 samples from 1,389 flocks gave a reactor rate of from 0.48 percent to 1.4 percent. These results indicate that Mycoplasmosis remains a significant disease problem.

Infectious Laryngotracheitis (LT) virus was isolated from 20 to 175 consignments (12 percent) of chickens with clinical respiratory infection. A combination of fluorescent antibody (FA) and virus isolation (VI) tests were used to examine 253 lots for one of three viruses. A total of 206 were positive (81.4 percent). Thirty were positive for Laryngotracheitis (11.8 percent), 38 for Newcastle Disease (15 percent) and 138 for Infectious Bronchitis (54.5 percent). These three agents contribute significantly to respiratory disease problems.

None of 121 serum samples from captive wild cranes, nor 79 samples from captive wild geese, were positive for MG or MS. None of 108 sera from cranes, nor 46 samples from geese, were positive for Newcastle Disease.

Project No. D-69

PROPAGATION OF AVIAN VIRUSES IN TISSUE CULTURE

Because infectious bronchitis has been a persistent, and at times serious, problem for Maryland broiler producers, this project has focused primarily on the infectious bronchitis virus (IBV). Although vaccination is used universally in this area, the continued regular occurrence of outbreaks of IB indicates that these vaccines are unsatisfactory. Perhaps this is because of the presence of serotypes of the virus other than those for which the vaccines were designed.

A new, improved method for serotyping IBV in tracheal organ culture, rather than in embyronating eggs, has been developed. This technique has made practicable a survey of the serotypes of IBV responsible for vaccine breaks in Maryland and elsewhere. We have demonstrated that a serotype designated JMK is responsible for the vaccine breaks in the Delmarva area, and that the Mass type vaccines currently in use do not confer adequate protection against this virus. We have also demonstrated that yet another serotype is responsible for vaccine breaks in Arkansas. These findings have been published or are in press.

This project has demonstrated that at least three poultry raising areas of the United States – Delmarva, Connecticut and Arkansas-are experiencing problems with IBV because vaccines of the proper serotype are unavailable. New vaccines will, no doubt, be introduced largely as a result of these investigations. If suitable vaccines are to be found, close surveillance of IB outbreaks will be necessary.

Future plans for the project include development of improved methods for serotyping IBV, investigation of the relationship of serotype to cross immunity, fundamental investigation of the antigens of IBV and extensive monitoring of field outbreaks of disease.

Project No. D-64

RESPIRATORY DISEASES OF POULTRY

A total of 137,542 chickens from 1,870 flocks were tested for *Mycoplasma gallisepticum* (MG). Of these 3,265 (2.4 percent) were positive. This represents a significant rise in the number of positive reactions from a year ago when 0.4 percent were positive. This indicates that MG is still present in the area and that continued monitoring is necessary if eradication is to be accomplished.

A direct complement-fixation (CF) test was developed to detect antibodies to MG in chicken serum. The CF test was compared to the MG serum plate (SP) and hemagglutination-inhibition (HI) tests. A good correlation among the three tests was found. Little cross-reactivity of MG and *Mycoplasma synoviae* (MS) was encountered with the CF test. This test may be a valuable adjunct in differentiating infections with these two agents.

Project No. D-52

FLUORESCENT ANTIBODY TECHNIQUE IN RESPIRATORY DISEASES OF POULTRY

The fluorescent antibody (FA) test, using conjugates for *Mycoplasma gallisepticum* (MG), *Mycoplasma synoviae* (MS) and and Infectious Bronchitis Virus, was used to detect these agents in the respiratory systems of birds showing signs of disease or for identifying field isolates.

There was complete agreement between FA tests and isolation of MG in 238 of 279 samples (85 percent). There were 21 FA negative, culture positive and 20 FA positive, culture negative samples. This compares favorably with the results of a comparison of respiratory virus isolations and FA (75 percent).

The FA test, using ultra-violet epi-illumination, was used to identify mycoplasma field isolates. Of 70 isolates screened by this method, 33 were MG, 25 were MS and 12 were other serotypes.

Presently available FA conjugates are not capable of differentiating strains of Infectious Bronchitis Virus.

Project No. D-59

A STUDY OF BOVINE RESPIRATORY DISEASES

Clinical specimens and serum samples were collected from 72 cattle herds. Infectious bovine rhinotracheitis (IBR) and SF-4 viruses were isolated and antibodies to these viruses were detected in these herds.

Bovine adenovius type 2 was isolated as an adventitious contaminant in 3 lots of commercially obtained primary bovine embryonic kidney (BEK) cell cultures. In a preliminary study, types 4, 5 and 6 bovine adenoviruses which were thought to grow only in primary calf testicular cells, grew in BEK clutures.

Intracellular localization and sequential development of IBR viral antigens were studied by the direct fluorescent antibody technique. The antigens appeared at the nucleo-cytoplasmic junction four hours after infection. Fluorescent granules were observed in the cytoplasm by the eighth hour, and by 12 hours the entire cytoplasm was fluorescing. Intranuclear fluorescence was never detected, even with the virus strains which produced type A intranuclear inclusions. The antigens stained by each conjugate reacted identically to DNA and protein inhibitors, indicating that the conjugates were probably staining the same viral antigens.

Project No. D-63

AN INVESTIGATION TO STUDY THE PROPAGATION OF AVIAN VIRUSES IN TISSUE CULTURE

Chicken tracheal cultures were used to study the stability of Infectious Bronchitis Virus (IBR) antigens to passage in tracheal cultures and chicken eggs. The stability was measured by virus neutralization tests. Massachusetts 41, Connecticut, Iowa 97 and Iowa 609 strains, which had been passed 10 times in tracheas and 10 times in eggs, remained antigenically stable.

The tracheal culture technique is currently being used to identify strains of IBV isolated from field outbreaks of the disease. Massachusetts 41 and Connecticut (contained in most commercial vaccines) are *not* the strains most frequently encountered in these outbreaks.

Project No. D-64

ETIOLOGY AND CONTROL OF AVIAN LEUKOSIS

Marek's Disease is the major cause of Avian Leukosis in broilers and young egg laying pullets. Methods for detection of Marek's Disease herpes virus (MDHV) are being investigated. Primary chicken kidney and duck embryo fibroblast cell cultures, embryonated eggs and live chicks are being compared for their sensitivity in detecting MDHV.

Specific fluorescent antibody conjugates were prepared in rabbits and chickens for detecting MDHV in cell cultures.

Investigations of the relationship of an associated Chicken Syncytial Virus (CSV) with MDHV indicated that the two are not related.

Pilot studies on the use of a complement-fixation test for detection of antibodies to MDHV indicate specificity, but antibody levels appear to be of a low order of magnitude.

Project No. D-68

STUDY OF BOVINE RESPIRATORY DISEASES

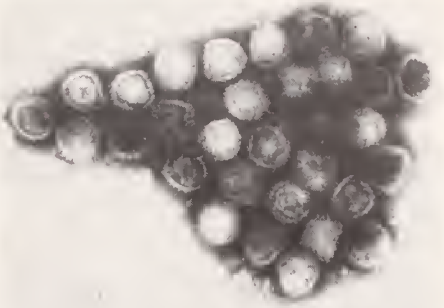
Hundreds of serum samples from cattle herds in Maryland have been tested yearly for infectious bovine rhinotracheitis (IBR), parainfluenza (PI_3) and bovine virus diarrhea (BVD) antibody. In some instances the serum tests were part of a vaccine evaluation and in others the tests offered diagnostic information. Isolates of IBR, PI_3 and BVD have been made from clinical specimens. Infectious bovine rhinotracheitis (IBR) was isolated from two goats with signs of severe respiratory illness.

The new bovine herpesvirus (strain DN-599), isolated from a steer, caused respiratory tract infection in calves with pneumonia after intranasal and intratracheal inoculation. In one experimental study, four of seven calves developed conjunctivitis; three died of the disease. Surviving calves were immune to the challenge of the virus eight weeks after inoculation despite the fact that antibody to the virus was not detected in these calves by serum neutralization test.

Electron microscopic observations on the sequential development of the new herpesvirus (strain DN-599) showed viral particles in the nucleus first at 12 hours post infection. Enveloped virus was seen at the same time.

Experimental work on the effect of polyriboinosinic: polyribocytidylic acid (poly I:C) on infectious bovine rhinotracheitis (IBR) in calves showed that Poly I:C, when

Calf with pneumonia and conjunctivitis following DN-599 inoculation



DN-599 herpesvirus (negatively stained) approximately 70,000 x.

administered intravenously (iv) three hours prior to challenge with IBR virus, produced sufficient interferon to reduce the severity of the respiratory illness. Depending on the dosage used, Poly I:C also reduced or prevented the pneumonic lesions in the lungs.

Project No. D-63

EQUINE RHINOPNEUMONITIS (EQUINE ABORTION DISEASE)

The problem in equine abortion is that there is no suitable vaccine available at present which will provide adequate protection. So our research is directed:

1) to evaluate the commercially available vaccine
2) to develop a suitable vaccine which will provide an adequate protection.

To evaluate the commercially available vaccine, horse breeding farms were selected which had horses vaccinated with the commercially available vaccine and compared with horses from the non-vaccinated farms. Pregnant mares were bled at regular intervals and sera were tested against the standard strain of Equine Herpes virus Type 1. There was no appreciable difference in serum antibody titers between vaccinated and non-vaccinated group. A direct relationship between the antibody titers and the occurrence of abortion could not be established.

Towards the development of efficient vaccine, first the isolation of equine abortion virus from field cases of abortion was undertaken. Several virus isolates were obtained belonging to type 1 equine herpes virus. One of these isolates, designated EAV 8, has different plaque morphology and other different characters. The suitability of this isolate as vaccine strain is being presently studied.

The major effort is given to developing a vaccine strain of equine abortion virus which will be suitable for vaccine production. Two approaches are taken using the standard EHV,TYL and representative field isolates including EAV 8. First, they are serially passaged in heterologous host cell lines for attenuation. They are at their 80th passage or over and presently are being tested in hamsters for any attenuation. Afterwards they will be tested in ponies. Second is the development of mutants. Several mutants have been isolated by clinical treatments and they are being studied at present in vitro and in hamsters for suitability as vaccine strain.

ADEQUACY OF THERMOREGULATORY RESPONSE TO COLD STRESS AS A FACTOR IN DECREASED DISEASE RESISTANCE

It is well known that exposing domestic animals to a severe and/or prolonged cold stress can result in the lowering of the animal's overall resistance to disease. The relationship between short-term cold stress and lowered resistance is quite possibly related to a failure of some aspect of the animal's thermoregulatory response.

The adequacy of an animal's thermoregulatory response to a cold stress is being studied by means of implanted thermocouples. This allows for the simultaneous measurement of temperature form several parts of the animal's body. Findings to date have shown that the small test animal (woodchuck, *Marmota monax*) is capable of substantial blood shunting during cold exposure. Such redistribution of blood, with the lowering of the temperature of various tissues within the body, allows the animal to more easily maintain its central or "core" temperature during the cold stress. If the animal is unable to maintain "core" temperature during the cold stress, resistance to disease at this critical time will be hampered.

Procedural details will be refined in the woodchucks before the utilization of ruminants (goats) is undertaken.

In addition to the physiological data, we are accumulating disease information on the woodchuck as it occurs within our group of test animals. It appears as though staphylococcal infections and infestations with the intermediate stage of the tapeworm, *Taenia crassiceps,* are prominent disease entities in the woodchuck.

Project No. O-71

PUBLICATIONS

1969 - 1973

Technical Bulletins

A159 Discovery and Growth. Survey of Agricultural Research in Maryland. Eightieth Annual Report of the Maryland Agricultural Experiment Station 1966-1967. I.C. Haut. 120 pp. April 1970.

A164 Progress Through Research. Survey of Agricultural Research in Maryland. Eighty-first Annual Report of the Maryland Agricultural Experiment Station 1967-1968. I.C. Haut. 135 pp. April 1970.

A170 Advances - A survey of Agricultural Research in Maryland. Eighty-second Annual Report of the Maryland Agricultural Experiment Station 1968-1969. I.C. Haut. 102 pp. April 1971.

A178 Maryland Agricultural Experiment Station Publications 1965-1970. I.C. Haut. 54 pp. Feb. 1972.

DEPARTMENT OF AGRICULTURAL AND EXTENSION EDUCATION

Miscellaneous Publications

733 Model for Evaluation of Secondary School Programs of Vocational Education in Agriculture. Alfred H. Krebs. Multilithed Circular, 68 pp. July 1969.

780 Man and His Environment: An Exploratory Study of the Value Placed on Trees. Irwin R. Jahns and F. Howard Forsyth. Multilithed Circular, 19 pp. April 1971.

821 Professional and Paraprofessional Role Differentiation. Christine S. Tennant and James W. Longest. Multilithed Circular, 23 pp. Jan. 1973.

Scientific Article

A1679 Characteristics of Families in Poverty in a Rural Maryland County. William A. Lynk. F. Howard Forsyth, and Virginia S. Krohnfeldt. Multilithed Publ., 21 pp. June 1971.

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS

Miscellaneous Publications

695 Demand for Shellfish in the United States. Richard E. Suttor and Parviz Aryan-Nejad. Multilithed Circular, 28 pp. July 1969.

697 The Transfer of Farm and Open Country Real Estate in Carroll County, Maryland, 1965. Ray A. Murrary and Edwin I. Cissel. Multilithed Circular, 31 pp. July 1969.

698 The Transfer of Farm and Open Country Real Estate in Harford County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 30 pp. July 1969.

697 The Transfer of Farm and Open Country Real Estate in Carroll County, Maryland. 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 31 pp. July 1969.

698 The Transfer of Farm and Open Country Real Estate in Harford County, Maryland. 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 30 pp. July 1969.

699 The Transfer of Farm and Open Country Real Estate in Anne Arundel County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 22 pp. July 1970.

700 The Transfer of Farm and Open Country Real Estate in Allegany County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 53 pp. Aug. 1970.

701 The Transfer of Farm and Open Country Real Estate in Baltimore County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 34 pp. July 1970.

702 The Transfer of Farm and Open Country Real Estate in Caroline County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 27 pp. July 1969.

704 The Transfer of Farm and Open Country Real Estate in Calvert County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 23 pp. July 1970.

706 The Transfer of Farm and Open Country Real Estate in Queen Anne's County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 26 pp. July 1969.

707 The Transfer of Farm and Open Country Real Estate in St. Marys County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 29 pp. July 1969.

708 The Transfer of Farm and Open Country Real Estate in Wicomico County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 30 pp. July 1969.

709 The Transfer of Farm and Open Country Real Estate in Prince Georges County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 29 pp. July 1969.

712 The Transfer of Farm and Open Country Real Estate in Somerset County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 30 pp. July 1969.

713 The Transfer of Farm and Open Country Real Estate in Washington County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 36 pp. July 1969.

714 Sources of Labor Productivity Variation on Dairy Farms, Istanbul Province, Turkey. John W. Wysong and Hanai H. Omar. Multilithed Circular, 16 pp. Sept. 1970.

715 The Transfer of Farm and Open Country Real Estate in Worcester County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 28 pp. July 1969.

716 The Transfer of Farm and Open Country Real Estate in Cecil County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 29 pp. July 1969.

717 An Analysis of the Role of Woodlot Owners in the Marketing Structure for Timber in Maryland. Russell F. McDonald, Harold D. Smith, and Stuart Ross. Multilithed Circular, 24 pp. Aug. 1969.

718 The Transfer of Farm and Open Country Real Estate in Dorchester County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 30 pp. July 1969.

719 The Transfer of Farm and Open Country Real Estate in Howard County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 24 pp. July 1969.

720 The Transfer of Farm and Open Country Real Estate in Talbot County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 25 pp. July 1969.

721 The Transfer of Farm and Open Country Real Estate in Charles County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 24 pp. July 1969.

723 The Transfer of Farm and Open Country Real Estate in Kent County, Maryland 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 29 pp. July 1969.

724 Seasonal Price Fluctuations for Maryland Grain. Russell F. McDonald and Jack L. Runyan. Multilithed Circular, 98 pp. Dec. 1969.

726 The Transfer of Farm and Open Country Real Estate in Montgomery County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 21 pp. July 1969.

727 The Transfer of Farm and Open Country Real Estate in Frederick County, Maryland 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 45 pp. July 1969.

728 Production of Christmas Trees in Maryland. Daymon W. Thatch and Russell F. McDonald. Multilithed Circular, 72 pp. 1970.

731 Interregional Competition in Maryland Produced, Fresh Market Green Beans. Jarvis L. Cain and Ulrich C. Toensmeyer. Multilithed Circular, 62 pp. Oct. 1969.

732 Marketing Christmas Trees in Maryland. Daymon W. Thatch and Russell F. McDonald. Multilithed Circular, 44 pp. 1970.

735 Interregional Competition in Maryland Produced, Fresh Market Sweet Corn. Jarvis L. Cain and Ulrich C. Toensmeyer. Multilithed Circular, 51 pp. Oct. 1969.

736 Christmas Trees as an Alternative Field Crop in Selected Areas in Maryland. Russell F. McDonald and Daymon W. Thatch. Multilithed Circular, 53 pp. Sept. 1969.

739 The Transfer of Farm and Open Country Real Estate in Garrett County, Maryland, 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 25 pp. July 1969.

740 The Chesapeake Bay Oyster Fisheries: An Econometric Analysis. Richard E. Suttor and Thomas. D. Corrigan. Multilithed Circular, 50 pp. July 1970.

741 Interregional Competition in Maryland Produced, Fresh Market Tomatoes. Jarvis L. Cain and Ulrich C. Toensmeyer. Multilithed Circular, 57 pp. Oct. 1969.

742 An Examination and Assessment of Questions and Allegations Pertaining to the Egg Market. John Hampton Mills and Filmore E. Bender. Multilithed Circular, 30 pp. Aug. 1970.

743 Marketing Livestock in Maryland. Russell F. McDonald, Olivier Lafourcade, and Vincent R. McDonald. Multilithed Circular, 62 pp. March 1970.

748 Criteria for State-County Sharing of County Functional Costs in Maryland. William Paul Walker. Multilithed Circular, 27 pp. March 1970.

750 The DelMarva Poultry Industry in Interregional Competition. James E. Via and John L. Crothers. Multilithed Circular, 49 pp. March 1970.

753 The Transfer of Farm and Open Country Real Estate in Maryland, 1964 and 1965. Ray A. Murray and Edwin I. Cissel. Multilithed Circular, 77 pp. March 1970.

765 Highlights and Synthesis of Selected Research in Scientific Administration Applied to the Dairy Farm Firm. John W. Wysong. Multilithed Circular, 13 pp. Oct. 1970.

776 State and County Tax Potentials in Maryland. Wm. Paul Walker. Multilithed Circular, 19 pp. Feb. 1971.

779 Catfish Culturing - A Situation Report. Richard J. Marasco. Multilithed Circular, 50 pp. Feb. 1971.

790 An Analysis of Non-Industrial Woodland Owner's Attitudes Toward Timber Sales on the Southern Eastern Shore of Maryland, 1970. Duk-Joong Won and Ian W. Hardie. Multilithed Circular, 74 pp. Sept. 1971.

791 Vertical Integration in U. S. Agro-Industries, Need for Research in India. John R. Moore. Indian Jour. Commerce 23 Pt. 3(84):81-86. Sept. 1970.

792 Interregional Competition in the Broiler Industry: A Computer Simulation Model - Volume I. V.W. Benson, F.E. Bender, and O. Lafourcade. Multilithed Circular, 81 pp. March 1972.

793 Interregional Competition in the Broiler Industry: A Computer Simulation Model - Volume II. V.W. Benson, F.E. Bender, and O. Laforcade. Multilithed Circular, 64 pp. March 1972.

796 Least Cost World Trade Patterns for Grains and Meats. John R. Moore, Sammy Elaassar, and Billy V. Lessley. Multilithed Circular, 45 pp. Dec. 1971.

802 The Chesapeake Bay Fisheries: An Economic Profile. Richard J. Marasco. Multilithed Circular, 203 pp. Feb. 1972.

815 Assessment-Sales Ratio Studies. Sidney Ishee. Multilithed Circular, 14 pp. Feb. 1973.

825 The Economic Impact of Extending Unemployment Insurance to Agriculture in Maryland. Roger C. Covey and A. Stewart Holmes. Multilithed Circular, 170 pp. Nov. 1972.

Regular Bulletins

485 Man-Machine Interaction Systems for Feeding and Milking on Selected Maryland Dairy Farms. John W. Wysong. 14 pp. Oct. 1969.

488 The Commercial Turfgrass Industry in Maryland: Structure, Costs and Returns. Fred T. Arnold and Billy V. Lessley. 71 pp. May 1972.

Scientific Articles

A1459 The Economic Position of Maryland Agriculture in 1968. John W. Wysong. Ag. Econ. Mimeo. Series 22:15. May 1969.

A1473 A Simulation Study of Population, Education, and Income Growth in Uganda. Phillips Foster and Larry Yost. Amer. Jour. Agr. Econ. 51(3):576-591. Aug. 1969.

DEPARTMENT OF AGRICULTURAL ENGINEERING

Miscellaneous Publications

744 Influence of Electrical Energy on Plants: A Review. Fred Wheaton. Multilithed Circular, 38 pp. Aug. 1970.

754 New Harvesting System for Maryland Tobacco. P.N. Winn, Jr. (Agr. Engin.); J.H. Hoyert, C.G. McKee, G.A. Stevens (Agronomy). Multilithed Circular, 11 pp. Feb. 1970.

Regular Bulletin

489 Extended Aeration Treatment of Tomato Wastes. James A. Merkel. 19 pp. Nov. 1972.

Scientific Articles

A1533 An Engineering Study of the Chesapeake Bay Area Oyster Industry. Fred W. Wheaton. 1969 Proc. National Shellfish Assoc. 60:75-85. June 1970.

A1563 Effective and Economical Flame Control of the Alfalfa Weevil. W.L. Harris, Agr. Engin. Dept.; G.W. Leck, Ill, Cities Service Oil Co. Proc. Seventh Annual Symposium on Thermal Agr., pp. 20-23. 1971.

A1575 The Effect of Temperature on the Physicological Responses of Chickens. Kenneth E. Felton and Edmund Hoffmann. Presented at 1969 Winter Meeting ASAE Dec. 9-12, 1969. Paper No. 69-931:14.

A1588 Temperature and Relative Humidity Environments for Broiler Production. Kenneth E. Felton and Paul N. Winn, Jr. Proc. Sixth Ann. Meeting Southern Regional Avian Environmental Physiology and Bioengineering Study Group, pp. 31-51. Feb. 1, 1970.

A1616 Mechanical Harvesting and Handling of Sweet Potatoes. G.J. Burkhardt, W.L. Harris, L.E. Scott, and E.G. McKibben. Transactions ASAE 14 (3): 516-519. 1971.

A1635 Has Agricultural Engineering Defaulted the Poultry Processing Industry. James A. Merkel. Presented at the 1970 North Atlantic Regional Meeting of ASAE, Paper No. 70-302. 16 pp. Aug. 16-18, 1970.

A1660 A High-Pressure Steam Peeler for Fruits and Vegetables. G.J. Burkhardt, J.A. Merkel, and L.E. Scott. Paper Presented at Amer. Soc. Agr. Engineers Meeting Dec. 10, 1970. 18 pp.

A1665 Design Constraints on an Oyster Shucking Machine. F.W. Wheaton. Presented ASAE Meeting, Chicago, Ill. Dec. 8-11, 1970. Paper No. 70-584:15 pp.

A1677 Environmental Research at Maryland - Station Report. Kenneth E. Felton. Proc. Seventh Annual Meeting Southern Regional Avian Environmental Physiology and Bioengineering Study Group. 11 pp. Jan. 31, 1971.

A1722 Evaporative Cooling Possibilities in Delmarva Broiler Production. Kenneth E. Felton. Proc. Tenth Annual Broiler Housing Seminar, 1971. pp. 37-44.

A1723 Broiler Response to Varying Temperatures. Kenneth E. Felton and Charles J. Wabeck. Proc. Tenth Annual Broiler Housing Seminar, 1971. pp. 32-36.

A1747 Aeration Rates for Rapid Composting of Dairy Manure. G.B. Willson and J.W. Hummel. Proc. Cornell Univ. Agr. Waste Management Conf., Syracuse, N.Y., 1972. pp. 145-158.

A1751 Temperature and Light Studies at the University of Maryland Broiler Substation. Kenneth E. Felton and Charles J. Wabeck. Proc. Eighth Annual Meeting Southern Regional Avian Environmental Physiology and Bioengineering Study Group, 1972. pp. 103-112.

A1906 Controlling the Distribution Pattern of a Centrifugal Fertilizer Spreader Through Precise Spinner Loading. G.U. Schaffer, W.L. Harris, and J.W. Hummel. Amer. Soc. Agr. Engineers Paper No. 73-139. 28 pp. 1973.

Technical Bulletin

A171 Flaming for Control of Alfalfa Weevil in Maryland. W.L. Harris, C.G. Blickenstaff, N.A. Clark, A.L. Steinhauer, J.W. Neal, R.M. Coan and R.H. Ratcliffe. 43 pp. Feb. 1971.

DEPARTMENT OF AGRONOMY

Miscellaneous Publications

710 Soybean Variety Evaluations for Agronomic Performance in Maryland, 1961-1968. J.A. Schillinger, B.C. Caldwell, and H.G. Vest. Multilithed Circular, 15 pp. Dec. 1969.

734 Maryland 10: A Mosaic Resistant Variety of Maryland Tobacco. H.A. Skoog and M.K. Aycock. Multilithed Circular, 10 pp. Nov. 1969.

746 Performance of Maryland Tobacco Varieties and Breeding Lines, 1968. M.K. Aycock, Jr., H.A. Skoog, C.G. McKee, J.H. Hoyert, and O.E. Street. Multilithed Circular, 22 pp. July 1970.

774 Tephrosia Leaf Development: Index of Crop Yield and Bioclimate. J.J. Higgins and A.M. Decker. Multilithed Circular, 61 pp. Feb. 1971.

788 Feasibility of Marketing Maryland United Tobacco Leaf. J.H. Hoyert, C.G. McKee, P.N. Winn, and G.M. Beal. Multilithed Circular, 15 pp. Nov. 1971.

798 Performance of Maryland Tobacco Varieties and Breeding Lines, 1969-70. M.K. Aycock, Jr., H.A. Skoog, C.G. McKee, J.H. Hoyert, and C.L. Mulchi. Multilithed Circular, 28 pp. Jan. 1972.

805 1971 Maryland Soybean Variety Tests. J.A. Schillinger. Multilithed Circular, 22 pp. March 1972.

828 Performance of Winter Barley and Winter Wheat in Maryland, 1972. J.G. Shannon. Multilithed Circular, 16 pp. March 1973.

Regular Bulletin

487 Nitrogen Fertilization, Harvest Management, and Utilization of 'Midland' Bermudagrass (*Cynodon dactylon* (L.) Pers.). A.M. Decker, R.W. Hemken, J.R. Miller, N.A. Clark, and A.V. Okorie. 71 pp. Sept. 1971.

Scientific Articles

A1477 Effect of Anthracnose *(Colletotrichum trifolii)* Infection on Yield, Stand, and Plant Vigor of Alfalfa. D.K. Barnes, S.A. Ostazeski, J.A. Schillinger, and C.H. Hanson. Crop Sci. 9:344-346. May-June 1969.

A1483 Cave Features: Information Concerning the Nature and Genesis of Soils. D.S. Fanning. Soil Sci. Soc. Amer. Proc. 34(1):98-104. Jan.-Feb. 1970.

A1503 Effect of Phosphorus and Postassium on Alfalfa Root Anatomy. M.G. Schnappinger, Jr., V.A. Bandel, and C.B. Kresge. Agron. Jour. 61:805-808. Sept.-Oct. 1969.

A1507 Relationship of Pearl Millet to Milk Fat Depression in Dairy Cows. I. Cation Fertilization. J.P. Harner, R.W. Hemken, J.H. Vandersall, N.A. Clark, and B.A. Schneider. Jour. Dairy Sci. 52(8):1244-1248. Aug. 1969

A1508 Relationship of Pearl Millet to Milk Fat Depression in Dairy Cows. II. Forage Organic Acids as Influenced by Soil Nutrients. B.A. Schneider and N.A. Clark, Agron. Dept.; R.W. Hemken and J.H. Vandersall, Dairy Sci. Dept. Jour. Dairy Sci. 53(3):305-310. March 1970.

A1538 Soil Calcium Determination Using a Calcium Specific Ion Electrode. E.A. Woolson, J.H. Axley, and P.C. Kearney. Soil Sci. 109(5):279-281. 1970.

A1539 Phytotoxicity of Water Extracts of Fruit, Stems, and Roots of the Tomato Plant and a Technique for Its Determination. R. Walter Simmons and John H. Axley. Agron. Jour. 62:431-432. May-June 1970.

A1555 Comparison of a Colorimetric and a Coulometric Method for the Determination of Arsenic in Soil Digests. E.A. Woolson, J.H. Axley, and P.C. Kearney. Soil Sci. 3(3):158-162. March 1971.

A1561 Effect of Potassium on the Mineral Constituents of Pearl Millet and Sudangrass, B.A. Schneider and N.A. Clark. Agron. Jour. 62:474-477. July-Aug. 1970.

A1569 Triphenyl Tetrazolium Chloride Assay for Herbicidal Activity. G.W. Burt, J.V. Parochetti, and I.M. Wedderspoon. Proc. Northeast Weed Control Conf. 24:315. 1970.

A1570 Chickweed Control in Dormant Alfalfa. J.V. Parochetti. Proc. Northeast Weed Control Conf. 24:402-408. 1970.

A1571 Postemergence Weed Control in Corn with Combinations of Atrazine, Oil, and Phytotoxic Herbicides. J.V. Parochetti. Proc. Northeast Weed Control Conf. 24:413-415. 1970.

A1572 Giant Foxtail and Fall Panicum Control in Soybeans. J.V. Parochetti. Proc. Northeast Weed Control Conf. 24:409-412. 1970.

A1577 Differential Growth of Johnsongrass Selections. I.M. Wedderspoon and G.W. Burt. Weed Sci. Soc. of Amer. 18:6. 1970.

A1586 Free Iron Oxides: Rapid Determination Utilizing X-ray Spectroscopy to Determine Iron in Solution. D.S. Fanning, R.F. Korcak, and C.B. Coffman. Soil Sci. Soc. Amer. Proc. 34(5):941-946. Nov.-Dec. 1970.

A1604 Volatility of Dichlobenil. J.V. Parochetti, E.R. Hein, and S.R. Colby. Weed Sci. 19(1):28-31. Jan. 1971.

A1608 Effects of Irrigation, Nitrogen Fertilizer, Plant Population and Variety on the Physico-Chemical Properties of Maryland Tobacco. I. Agronomic Effects. Gerald W. Brown and Orman E. Street Proc. 5th World Tobacco Sci. Congress, Hamburg, Germany, 1970. Sonderdruck aus: "Beitrage zur Tabakforschung". Band 6 Heft. 3:148-154. March 1972.

A1609 Regional Tests with Contact and Systemic Tobacco Sucker Control Agents. IV. Maryland Tobacco. D.W. Spaulding, G.L. Steffens, and J.H. Hoyert. Tobacco Sci. XIV:98-100; Tobacco 171 (2): 21-23. 1971.

A1613 Correlation Between Available Soil Arsenic Estimated by Six Methods, and Response of Corn *(Zea mays* L.). E.A. Woolson, J.H. Axley, and P.C. Kearney. Soil Sci. Soc. Amer. Proc. 35(1):101-105. Jan.-Feb. 1971.

A1626 Effects of Irrigation and Related Treatments on Agronomic and Physico-Chemical Properties of Maryland Tobacco. Gerald W. Brown, Claude G. McKee and Orman E. Street. Proc. 5th World Tobacco Sci. Congress, Hamburg, Germany, 1970. Sonderdruck aus: "Beitrage zur Tabakforschung". Band 6.Heft.3:154-160. March 1972.

A1631 Contributions of Clay and Organic Matter to the Cation Exchange Capacity of Maryland Soils. W.R. Wright and J.E. Foss. Soil Sci. Sco. Amer. Proc. 36(1):115-118. 1972.

A1652 Growth of Johnsongrass Selections Under Different Temperatures and Dark Periods. G.W. Burt and Ian M. Wedderspoon. Weed Sci. 19(4):419-423. July 1971.

A1655 Factors Related to the Irrigation of Maryland Tobacco. 1. Agronomic Effects. Gerald W. Brown and Orman E. Street. Tobacco Sci. XVI:55-60;Tobacco 174(9):119-124. 1972.

A1661 Fall Panicum Control in No-Tillage Corn. J.V. Parochetti. Northeastern Weed Sci. Soc. Proc. 25:291-294. 1971.

A1662 The Effect of Vernolate, Row Width and Cultivation on Soybean Production and Foxtail Control. J.V. Parochetti. Northeastern Weed Sci. Soc. Proc 25:317-321. 1971.

A1673 Can Controlled Flaming Improve Bermudagrass Yields and Forage Quality? A.M. Decker and W.L. Harris. Proc. Eighth Annual Symposium on Thermal Agr., Sponsored by National LP-Gas Assoc. and Natural Gas Processors Assoc. pp. 60-67. Jan. 28-29, 1971.

A1682 Effect of Soil Factors on the Distribution of *Rhizobium japonicum* Serogroups. David F. Bezdicek. Soil Sci. Soc. Amer. Proc. 36(2):305-307. March-April 1972.

A1691 The Chemistry and Phytotoxicity of Arsenic in Soils. E.A. Woolson, J.H. Axley, and P.C. Kearney. Soil Sci. Soc. Amer. Proc. 35(6):938-943. Nov.-Dec. 1971.

A1694 Studies on Weather Fleck of Tobacco in Taiwan. O.E. Street, C.H. Sung, H.Y. Wu, and H.A. Menser, Jr. Tobacco Sci. 15:128-131. 1971.

A1697 Soil Morphology, Water Tables, and Iron Relationships in Soils of the Sassafras Drainage Catena in Maryland. D.S. Fanning, R.L. Hall, and J.E. Foss. Proc. International Soc. Soil Sci. Meeting on Genesis and Use of Hydromorphis Soils (Hohenheim, W. Germany, Sept. 1971). Sonderdruck Reprint:71-79. 1972.

A1726 Improved Reciprocal Grafting Technique for Soybeans (Glycine Max L.). D.F. Bezdicek, B.H. Magee, and J.A. Schillinger. Agron. Jour. 64:558. July-Aug. 1972.

A1738 Johnsongrass Control in Non-Cropland. J.V. Parochetti. Proc. N.E. Weed Sci. Soc. 26: 41-46. New York City. Jan. 5, 6, 7, 1972.

A1739 Preemergence Herbicides Plus Postemergent Chloroxuron on Soybeans. J.V. Parochetti, R.W. Feeny, and S.R. Colby. Weed Sci. 20(c):548-553. Nov. 1972.

A1740 Herbicides for Corn on High Organic Matter Soils. J.V. Parochetti. Proc. N.E. Weed Sci. Soc. 26:31-35. New York City. Jan. 5, 6, 7, 1972.

A1752 Soil Organic Matter on Activity of Acetanilides, CDAA, and Atrazine. James V. Parochetti. Weed Sci. Soc. Amer. 21(3):157-160. May 1973.

A1760 Comparison of Soil Incorporated Organic Additives to Seedbeds to Improve Transplant Production in Maryland Tobacco. J.H. Hoyert. Tobacco Sci. XVI:95-96. 1973;Tobacco 174(17):27-28. 1973.

A1761 Combining Ability Estimates for Weather Fleck in *Nicotiana tabacum* L. M.K. Aycock, Jr. Crop Sci. 12:672-674. Sept.-Oct. 1972.

A1843 Postemergence and Postdirected Broadleaved Weed Control for Soybeans. J.V. Parochetti. Proc. N.E. Weed Sci. Soc. 27:75-79. 1973.

A1844 Repeated Summer Tillage for Johnsongrass Eradication. J.V. Parochetti. Proc. N.E. Weed Sci. Soc. 27:164-166. 1973.

DEPARTMENT OF ANIMAL SCIENCE

Miscellaneous Publications

657 Value of Menhaden, *Brevoortia tyrannus,* Meal as a Protein Supplement to Cottonseed Meal-Corn Diets for Pigs. Robert R. Kifer and Edgar P. Young. Fishery Industrial Res. 5(4):133-142. Aug. 1969.

725 Cooperative Research University of Maryland and Wye Plantation. W.W. Green and W.R. Stevens. Multilithed Circular, 21 pp. Aug. 1969.

Scientific Articles

A1387 The Dependence of Growth Hormone Upon an Intact Pancreas for Adipokinesis. Robert W. Farmer, Kassim B. Ismail, Emory C. Leffel, and Sitarama Lakshmanan. Life Sci. 8(1):895-904. 1969.

A1388 Substances Affecting Fat Mobilization in the Urine of Fasting Sheep. R.W. Farmer, E.C. Leffel, and S. Lakshmanan. Animal Sci. 30(2):207-213. Feb. 1970.

A1586 Effect of Dietary Fish Oil on Fatty Acid Composition and Palatability of Pig Tissues. Robert R. Kifer, Preston Smith, Jr., and E.P. Young. Fishery Bulletin 69(2):281-302. April 1971.

A1587 The Effect of Increasing Dietary Cell Wall Content on the Digestibility of Hemicellulose and Cellulose in Swine and Rats. J.E. Keys, Jr., P.J. Van Soest, and E.P. Young. Jour. Animal Sci. 31:1172-1177. Dec. 1970.

A1591 Neonatal Lambs in a Gnotobiotic Environment. J.H. Soares, Jr., E.C. Leffel, and R.K. Larsen. Jour. Animal Sci. 31:733. Oct. 1970.

A1612 Radioimmunoassay Determination of LH Concentration in the Serum of Female Pigs. P.L. Rayford, H.J. Brinkley, and E.P. Young. Endocrinology 88:707-713. March 1971.

Technical Bulletins

A163 Use of Body Measurements to Predict the Weights of Wholesale Cuts of Beef Carcasses: Wholesale Rib of 900 Pound Steers. W.W. Green, W.R. Stevens, and Martha B. Gauch. 21 pp. June 1969.

A165 Use of Body Measurements to Predict the Weights of Wholesale Cuts of Beef Carcasses: Wholesale Round of 900 Pound Steers. W.W. Green, W.R. Stevens, and Martha B. Gauch. 18 pp. Sept. 1969.

A167 Use of Body Measurements to Predict the Weights of Wholesale Cuts of Beef Carcasses: Wholesale Rib of 1000 Pound Steers. W.W. Green, W.R. Stevens, and Martha B. Gauch. 20 pp. July 1970.

A168 Use of Body Measurements to Predict the Weights of Wholesale Cuts of Beef Carcasses: Wholesale Round of 1000 Pound Steers. W.W. Green, W.R. Stevens, Martha B. Gauch, and J.L. Carmon. 19 pp. Sept. 1970.

A169 Use of Body Measurements to Predict the Weights of Wholesale Cuts of Beef Carcasses: Wholesale Arm Chuck of 900 Pound Steers. W.W. Green, W.R. Stevens, and Martha B. Gauch. 25 pp. Nov. 1970.

A173 Use of Body Measurements to Predict the Weights of Wholesale Cuts of Beef Carcasses: Wholesale Arm Chuck of 1000 Pound Steers. W.W. Green, W.R. Stevens, and Martha B. Gauch. 18 pp. Feb. 1971.

A174 Use of Body Measurements to Predict the Weights of Wholesale Cuts of Beef Carcasses: Wholesale Short Loin of 900 Pound Steers. W.W. Green, W.R. Stevens, and Martha B. Gauch. 19 pp. May 1971.

A175 Use of Body Measurements to Predict the Weights of Wholesale Cuts of Beef Carcasses: Wholesale Short Loin of 1000 Pound Steers. W.W. Green, W.R. Stevens, and Martha B. Gauch. 16 pp. May 1971.

A176 Use of Body Measurements to Predict the Weights of Wholesale Cuts of Beef Carcasses: Wholesale Sirloin Butt of 900 Pound Steers. W.W. Green, W.R. Stevens, and Martha B. Gauch. 16 pp. May 1971.

A177 Use of Body Measurements to Predict the Weights of Wholesale Cuts of Beef Carcasses: Wholesale Sirloin Butt 1000 Pound Steers. W.W. Green, W.R. Stevens, and Martha B. Gauch. 16 pp. July 1971.

A179 Use of Body Measurements to Predict the Weights of Wholesale Cuts of Beef Carcasses: Combined Cuts of 1000 Pound Steers. W.W. Green, W.R. Stevens, and Martha B. Gauch. 33 pp. May 1972.

A180 Use of Body Measurements to Predict the Weights of Wholesale Cuts of Beef Carcasses: Combination Cuts of 900 Pound Steers. W.W. Green, W.R. Stevens, and Martha B. Gauch. 33 pp. Oct. 1972.

DEPARTMENT OF BOTANY

Miscellaneous Publication

789 Woody Plants of Maryland. Russell G. Brown and Melvin L. Brown. Book (Case Bound). LX Plus 347 pp. 1972.

Scientific Articles

A1358 Absorption and Toxicity of Beryllium and Lithium in *Chlorella vannielii* Shihira and Krauss. Edward P. Karlander and Robert W. Krauss. Chesapeake Sci. 13(4):24-253. Dec. 1972.

A1462 Comparative in Vitro Fungitoxicity of Some Mercurial Fungicides. Geroge A. Bean, Phytopathology 57:644 (Abst.) 1967.

A1479 Influence of Dimethyl Sulfoxide (DMSO) on Conidial Pigmentation and Consequent UV Light Sensitivity of Aflatoxin Producing Strains of *Aspergillus flavus*. G.A. Bean, G.W. Rambo, and W.L. Klarman. Life Sci. 8(Part II):1185-1191. 1969.

A1500 Fatty Acids of the Mycelia and Conidia of *Fusarium oxysporum* and *Fusarium* roseum. G.W. Rambo and G.A. Bean. Canadian Jour. Microbiology 15:967-968. 1970.

A1505 Sterols of Chlorella–III. Species Containing Ergosterol. Glenn W. Patterson. Comp. Biochem. Physiol. 31:391-394. 1969.

A1509 Photoinduced Perithecial Formation by *Nectria haematococca* on Media Containing L-tyrosine; L-phenylalanine; or D-glucose + $NaNo_3$ as Sole Carbon and Nitrogen Sources. C.R. Curtis. Canadian Jour. Microbiology 15 (8): 863-868. 1969.

A1523 Environmentally-Induced Changes in the Fatty Acids of Chlorella. Leal G. Dickson, Raymond A. Galloway, and Glenn W. Patterson. Plant Physiology 44(10):1413-1416. Oct. 1969.

A1540 Comparison of UV-induced Delay in Germination in Pigmented and Pigmentinhibited Conidia of *Aspergillus carbonarius*. C.R. Curtis. Radiation Botany 10:125-130. 1970.

A1545 Identification and Influence of Sterols Plus DMSO on the Growth and Survival of *Fusarium roseum*. R.W. Tillman and G.A. Bean. Mycologia 62:428-436. 1970.

A1550 Chemical Composition of Nematodes. L.R. Krusberg. Plant Parasitic Nematodes 2:213-234. 1971.

A1558 Dimethyl Sulfoxide Inhibition of Aflatoxin Synthesis by *Aspergillus flavus*. George A. Bean, William L. Klarman, G.W. Rambo and Joseph B. Sanford. Photopathology 61:380-382. 1971.

A1562 Effect of Culture Temperature on Fatty Acid Composition of *Chlorella sorokiniana*. Glenn W. Patterson. Lipids 5(2):597-600. July 1970.

A1589 Antimycin A-Resistant Respiratory Systems in *Ustilago maydis* and *Neurospora sitophila*. J.L. Sherald and H.D. Sisler. Plant Physiol. 46:180-182. 1970.

A1593 Survival and Growth of the Mycoparasite *Darluca filum*. G.W. Rambo and G.A. Bean. Phytopathology 60:1436-1440. 1970.

A1594 Metabolic Effects Related to Fungitoxicity of Carboxin. Nancy N. Ragsdale and H.D. Sisler. Phytopathology 60(10):1422-1427. Oct. 1970.

A1602 Histopathology of and Oxidative Enzyme Patterns in Wando Peas Infected with Two Populations of *Ditylenchus dipsaci*. R.S. Hussey and L.R. Krusberg. Phytopathology 60(12):1818-1825. Dec. 1970.

A1605 Gene Mutation Eliminating Antimycin A-Tolerant Electron Transport in *Ustilago maydis*. S.G. Georgopoulos and H.D. Sisler. Jour. Bacteriology 103(3):745-750. Sept. 1970.

A1606 The Distribution of Sterols in Algae. Glenn W. Patterson. Lipids 6(2):120-127. 1971.

A1614 Nucleolar Number at Premeiotic and Mitotic Interphase in Maize. D.T. Morgan, Jr. Cytologia-International Jour. Cytology 36(4):669-673. Dec. 25, 1973.

A1629 Localization of the Site of Action of a Fungitoxic Benomyl Derivative. G.P. Clemons and H.D. Sisler. Pesticide Biochemistry and Physiology 1(1):32-43. March 1971.

A1633 Disc-electrophoretic Patterns of Enzymes and Soluble Proteins of *Ditylenchus dipsaci* and *Ditylenchus triformis*. R.S. Hussey and L.R. Krusberg. Jour. Nematology 3(1):79-84. Jan. 1971.

A1636 Comparative Anatomy and Taxonomy of Ulmaceae. Edward M. Sweitzer. Jour. Arnold Arboretum 52(4):523-585. Oct. 1971.

A1637 Disc Electrophoretic Comparisons of Proteins and Peroxidases from *Phaseolus vulgaris* Leaves Infected with *Agrobacterium tumefaciens*. C.F. Curtis. Canadian Jour. Botany 49(3):333-337. 1971.

A1646 Effect of Dimethyl Sulfoxide on the Sclerotia of *Sclerotium rolfsii*. J.H. Melhuish, Jr. and G.A. Bean. Canadian Jour. Microbiology 17:429-431. 1971.

A1659 14a-Methyl-5a-Ergost-8-En-3b-01 and 14a-Methyl-5a-Ergosta-8,24 (28)-Dien-3b-01 from Triparanol-Treated *Chlorella emersonii*. Phillip J. Doyle, Glenn W. Patterson, Samson R. Dutky, and Charles F. Cohen. Phytochemistry 10:2093-2098. 1971.

A1664 Control of *Pratylenchus penetrans* in Heavy Greenhouse Soil. L.R. Krusberg. Plant Disease Reporter 55(3):276-279. March 1971.

A1669 Increases in Peroxidese Isoenzyme Activity in Bean Leaves Exposed to Low Doses of Ozone. C.R. Curtis and R.K. Howell. Phytopathology 61(10):1306-1307. Oct. 1971.

A1675 Organic Acids of *Ditylenchus triformis* and *Turbatrix aceti*. Jessica M. Castillo and L.R. Krusberg. Jour. Nematology 3(3):284-288. July 1971.

A1687 Relation between Structure and Retention Time of Sterols in Gas Chromatography. Glenn W. Patterson. Analytical Chem. 43:1165. 1971.

A1690 Mode of Action of Benzimidazole Fungicides. H.D. Sisler. Proc. Second International IUPAC Congress Pesticide Chem. V, Gordon & Breach, New York, 1972. pp. 323-335. 323-335.

A1698 Sterols of Some Chesapeake Bay Algae. P.J. Doyle and G.W. Patterson. Comparative Biochemistry and Physiology 41B:355-358. 1972.

A1700 Fatty Acid Composition of *Turbatrix aceti* and Its Culture Medium. L.R. Krusberg. Comparative Biochemistry and Physiology 41B:89-98. 1972.

A1703 Sclerotial Formations by Helminthosporium Maydis Race "T" on Corn Seed. O.D. Morgan. Plant Disease Reporter 35:755-756. 1971.

A1710 Action Spectrum of the Photoinduced Sexual Stage in the Fungus *Nectria haematococca* Berk. and Br. var. *cucurbitae* (Snyder and Hansen) Dingley. C.R. Curtis. Plant Physiology 49:235-239. 1972.

A1714 A Study of Four Weed Hosts of Sclerotinia Species in Alfalfa Fields. O.D. Morgan. Plant Disease Reporter 55:1087-1089. 1971.

A1718 Triparanol Inhibition of Sterol Biosynthesis in *Chlorella emersonii.* P.J. Doyle, G.W. Patterson, S.R. Dutky and M.J. Thompson. Phytochemistry 111:1951-1960. 1972.

A1728 Production of the Phytoalexin, Hydroxyphaseolin, in Soybean Leaves Inoculated with Tobacco Necrosis Virus. W.L. Klarman and F. Hammerschlag. Phytopathology 62(7):719-721. July 1972.

A1729 The Soybean Phytoalexin, Hydroxyphaseollin, Induced by Fungicides. J.J. Reilly and W.L. Klarman. Phytopathology 62(10):1113-1115. Oct. 1972.

A1731 The Woods and Flora of the Florida Keys: "Pinnatae." Barrett Nelson Rock. Smithsonian Contributions to Botany Number 5:1-35. 1972.

A1756 Light and Calcium Interactions in *Chlorella* Inhibited by Sodium Chloride. Phrosene E. Chimiklis and Edward P. Karlander. Plant Physiology 51:48-56. 1973.

A1757 The Sterols of *Nitella flexilus* and *Chara vulgaris.* Glenn W. Patterson. Phytochemistry 11:3481-3483. 1972.

A1758 Isolation and Identification of Two Novel Sterols. *Chlorella ellipsoidea.* Leal G. Dickson and Glenn W. Patterson, Dept. of Botany, Univ. of Md.; Charles F. Cohen and Samson R. Dutky, Insect Physiology Laboratory, Ent. Res. Div., USDA. Phytochemistry 11:3473-3480. 1972.

A1762 Differential Action of Benomyl and Methyl-2-benzimidazolecarbamate (MBC) in *Saccharomyces pastorianus.* Richard S. Hammerschlag and Hugh D. Sisler. Pesticide Biochemistry and Physiology 2:123-131. 1972.

A1767 Sterols and Fatty Acids of Some Aquatic Phycomycetes. George A. Bean, Glenn W. Patterson, and Jerome J. Motta. Comparative Biochemistry and Physiology 43:935-940. 1972.

A1768 Occurrence of Aflatoxins and Aflatoxin Producing Strains of *Aspergillus flavus* in Soybeans. George A. Bean, John A. Schillinger and William L. Klarman. Applied Microbiology 24:437-439. 1973.

A1775 Inhibition of Sterol Biosynthesis in *Chlorella ellipsoidea* by AY-9944. Leal G. Dickson and Glenn W. Patterson. Lipids 7:635-643. 1972.

A1776 Effect of Chloroneb on Growth and Metabolism of *Ustilago maydis.* Ronald W. Tillman and H.D. Sisler. Phytopathology 63:219-225. 1973.

A1802 Selective Inhibition of Antimycin A-insensitive Respiration in *Ustilago maydis* and *Ceratocystis ulmi.* James L. Sherald and Hugh D. Sisler. Plant & Cell Physiol. 13:1039-1052. 1972.

A1805 Soybean Phytoalexin, Hydroxyphaseollin, Induced by Ultraviolet Irradiation. M.A. Bridge and W.L. Klarman. Phytopathology 63(5):606-609. 1972.

A1815 Mode of Action of Triarimol in *Ustilago maydis.* Nancy N. Ragsdale and Hugh D. Sisler. Pesticide Biochemistry and Physiology 3:20-29. 1973.

A1824 Benomyl and Methyl-2-benzimidazolecarbamate (MBC): Biochemical, Cytological and Chemical Aspects of Toxicity to *Ustilago maydis* and *Saccharomyces cerevesiae.* Richard S. Hammerschlag and Hugh D. Sisler. Pesticide Biochemistry and Physiology 3:42-54. 1973.

A1833 Lipid and Fatty Acid Composition of Females and Eggs of *Meloidogyne incognita* and *M. arenaria.* L.R. Krusberg, R.S. Hussey and C.L. Fletcher. Comparative Biochemistry and Physiology 45B:335-341. 1973.

Technical Bulletin

A172 Flora and Ecology of Assateague Island. Elizabeth A. Higgins, Robert D. Rappleye, and Russell G. Brown. 70 pp. Jan. 1971.

DEPARTMENT OF DAIRY SCIENCE

Miscellaneous Publications

738 Lipid Metabolism in the Rumen. Mark Keeney. Third International Symposium on the Physiology of Digestion and Metabolism in the Rumen. Cambridge University, Cambridge, England - Aug. 18-23, 1969. pp. 479-502.

745 Nonfat Dry Milk Solids in Ice Cream. W.S. Arbuckle. Dairy & Ice Cream Field 152(3):48. Dec. 1969.

760 Ice Cream Ingredients: Advances in the Processing of Milk Solids, Sugar Solids and Newly Developed Materials for Use in Ice Cream Manufacture. W.S. Arbuckle. Proc. XVIII International Dairy Congress, 1E:396. 1970.

763 Flecking Defect in Chocolate Ice Cream. W.S. Arbuckle and J.T. Layton. Amer. Dairy Review 33(2):34, 51, 52. Feb. 1971.

Scientific Articles

A1352 Pancreatic Amylase Secretion by Young Calves. J.L. Morrill, W.E. Stewart, and R.J. McCormick. Jour. Dairy Sci. 53:72-78. Jan. 1970.

A1508 Relationship of Pearl Millet to Milk Fat Depression in Dairy Cows. II. As Influenced by Soil Nutrients and Organic Acids. B.A. Schneider, N.A. Clark, R.W. Hemken, and J.H. Vandersall. Jour. Dairy Sci. 53:305-310. March 1970.

A1525 Utilization of Corn Silage Carotene as Compared to Pelleted Alfalfa Hay Carotene by Holstein Steers. R.W. Miller, R.W. Hemken, D.R. Waldo and L.A. Moore. Jour. Animal Sci. 30:984-987. June 1970.

A1537 Iodine. R.W. Hemken. Jour. Dairy Sci. 53(8):1138-1143. 1971.

A1542 Effect of Ethyl Alcohol on the Vitamin A Status of Holstein Heifers. R.W. Miller and R.W. Hemken. Jour. Dairy Sci. 52(12):1998-2000. Dec. 1969.

A1590 Utilization of Ethanol and Its Effect on Fatty Acid Patterns in Ruminants. K. Pradhan and R.W. Hemken. Jour. Dairy Sci. 53(12):1739-1746. 1971.

A1598 Rumen Methanol in Vivo and in Vitro. Z.M. Vantcheva, K. Pradhan, and R.W. Hemken. Jour. Dairy Sci. 53(10):1511-1514. 1971.

A1622 Effect of Homogenized Embryos on IUD-Induced Luteal Regression in the Ewe. J.E. Warren, Jr., H.W. Hawk, and W.F. Williams. Jour. Aminal Sci. 32(3):496-499. 1971.

A1632 Goiterogenic Effects of a Corn Silage-Soybean Meal Supplemented Ration. R.W. Hemken, J.H. Vandersall, B.A. Sass, and J.W. Hibbs. Jour. Dairy Sci. 54(1):85-88. Jan. 1971.

A1638 Enhancement by Exogenous Estradiol of IUD Induced Luteal Regression in the Ewe. J.E. Warren, Jr. and H.W. Hawk. Biology of Reproduction 4:48. 1971.

A1648 Nutritive Value of Corn Silage as Influenced by Grain Content. R.W. Hemken, N.A. Clark, H.W. Goering, and J.H. Vandersall. Jour. Dairy Sci. 54(3): 383-389. 1971.

A1663 Effects of Various Levels of Sulfur Upon Cellulose Digestion in Purified Diets and Lignocellulose Digestion in Corn Fodder Pellets *In Vitro*. J.S. Barton, L.S. Bull, and R.W. Hemken. Jour. Animal Sci. 33(3):682-685. 1971.

A1705 Rapid Vitamin E Method for Detecting Adulteration of Dairy Products with Non-Coconut Vegetable Oils. Mark Keeney, K.C. Bachman, H.H. Tikriti, and R.L. King. Jour. Dairy Sci. 54(11):1702-1703. Nov. 1971.

A1724 Survival of *Streptococcus lactis* and *Leuconostoc citrovorum* Following Exposure to N-methyl-N-nitro-N-nitrosoquanidine. D. C. Westhoff and P. Adams. Jour. Dairy Sci. 55(6):865-866. June 1972.

A1737 Iodine Intake Related to Milk Iodine and Performance of Dairy Cattle. R.W. Hemken, J.H. Vandersall, M.A. Oskarsson, and L.R. Fryman. Jour. Dairy Sci. 55(7):931-934. July 1972.

A1780 Sulfur Source on *in Vitro* Cellulose Digestion and *in Vivo* Ration Utilization, Nitrogen Metabolism and Sulfur Balance. L.S. Bull and J.H. Vandersall. Jour. Dairy Sci. 56:106-112. Jan. 1973.

A1800 Identification of Bacteria Isolated from Pasteurized Milk Following Refrigerated Storage. Carol Credit, Randy Hedeman, Patricia Heywood and Dennis Westhoff. Jour. Milk and Food Tech. 35(12):708-709. Dec. 1972.

A1816 The Fate of *Salmonella typhimurium* and *Staphylococcus aureus* in Cottage Cheese Whey. Dennis C. Westhoff and Thais Engler. Jour. Milk and Food Tech. 36(1):19-22. Jan. 1973.

Technical Bulletin

A158 The Effect of Nitrogen Fertilization on the Yield and Feeding Value of Corn Silage. R.W. Hemken, J.H. Vandersall, and N.A. Clark. 7 pp. Feb. 1969.

DEPARTMENT OF ENTOMOLOGY

Miscellaneous Publications

603 Low Volume Spraying. Elroy R. Krestensen and Castillo Graham. Pennsylvania Fruit News 46(4):20-24. 1967.

604 The Effects of Various Anaesthetics on the Action of DDT on *Anopheles* Larvae. Sheldon A. White and Jack Colvard Jones. Mosquito News 28(1):29-33. March 1968.

650 Further Tests for the Control of Apple Pests with Concentrate Sprays from 3 to 66X. Elroy E. Krestensen and Castillo Graham. Penin. Hort. Soc. 57(5):19-22. 1967.

673 An Evaluation of Insecticides for the Control of *Myzus persicae* (Sulzer) on Spinach. E. David Thomas and L.P. Ditman. Trans. Penin. Hort. Soc. 57(5):29-36. 1967.

705 The Brood Rearing Capability of Caged Honey Bees Fed Dandelion and Mixed Pollen Diets. E.W. Herbert, W.E. Bickley and H. Shimanuki. Proc. Twenty-Second International Apicultural Congress 63(1):215-218. Feb. 1970.

751 Elements of a Ph.D. Program in Entomology. William E. Bickley. Bulletin Ent. Soc. Amer. 16(1):16-17. March 1970.

755 Insecticide Tests for the Control of European Corn Borer on Peppers in Maryland. Michael Tysowsky, Jr. Trans. Penin. Hort. Soc. 59:22-25. 1970.

769 Progress in Controlling Bird Damage to Crops. Donald H. Messersmith. Business Farming 41(6):15-17. Sept.-Oct. 1970.

770 A List of the Aphids of the District of Columbia, Maryland and Virginia. Mortimer D. Leonard and Theodore L. Bissell. Multilithed Circular, 129 pp. Nov. 1970.

775 TEM - Potential Control of Red-winged Blackbirds. Donald H. Messersmith. Pest Control 39(2):35, 40-41, Feb. 1971.

783 Effect of Enzyme-Inducing Agents on Fat Storage and Toxicity of Insecticides. Robert E. Menzer and John A. Rose. Proc. Second IUPAC International Congress Pesticide Chem., Tel Aviv, 1971. Vol. 2:257-265. 1972.

818 Observations on Larvae and Pupae of Aedes atropalpus (Coq.) Confined to a Bottom Air-water Interface. William E. Bickley and John B. Duvall. Mosquito News 32(4). 1 pp. Dec. 1972.

Scientific Articles

A1335 Tabanidae of Maryland. Patrick H. Thompson. Trans. Amer. Entomol. Soc. 93:463-519. 1967.

A1414 Cache Valley Virus in the Del Mar Va Peninsula. IV. Biological Transmission of the Virus by *Aedes solicitans* and *Aedes taeniorhynchus*. Thomas M. Yuill and Patrick H. Thompson. Amer. Jour. Tropical Medicine and Hygiene 19(3):513-519. 1970.

A1421 Hemocytes and the Problem of Tumors in Insects. Jack Colvard Jones. Jour. National Cancer Institute 31:481-485. 1969.

A1428 Recent Studies on the Morphology and Physiology of the Reproductive System of *Aedes aegypti*. Jack Colvard Jones. Proc. XIII International Congress Ent., pp. 391-392. Moscow 1971.

A1469 A New *Melanaspis* from Jamaica on Bromeliad. John A. Davidson. Proc. Ent. Soc. Washington 72(1):33-36. March 1970.

A1470 Description and Biological Notes on the Larvae of *Anthicus heroicus* Casey. (Coleoptera: Anthicidae). John A. Davidson and Francis E. Wood. The Coleopterists' Bulletin 23(1):5-8. 1969.

A1471 Phagocytic Haemocytes in Unfixed *Galleria mellonella* Larvae. Richard A. Werner and Jack Colvard Jones. Jour. Insect Physiology 15:425-437. 1969.

A1478 The Effects of Ligaturing *Galleria mellonella* Larvae on Total Haemocyte Counts and on Mitotic Indices Among Haemocytes. Jack Colvard Jones and Daisy P. Liu. Jour. Insect Physiology 15:1703-1708. 1969.

A1482 The Subcoxa of the Aphid Hind Leg. Theodore L. Bissell. Proc. Ent. Soc. Washington 71(2):133-140. June 1969.

A1492 Control of Orchard Pests with Full and Three-quarter Strength Concentrate Sprays. E.R. Krestensen, Castillo Graham and L.O. Weaver. Trans. Penin Hort. Soc. 58:29-32. 1968.

A1493 Evaluation of Acaricides for Orchard Mite Control. Elroy E. Krestensen and Castillo Graham. Trans. Penin. Hort. Soc. 58:33-35. 1968.

A1498 Studies on the Unattractiveness of Inseminated *Aedes aegypti*. Jack Colvard Jones. Proc. Int. Conf. on "L'Influence Des Stimuli Externes Sur La Gametogenese Des Insectes." 189:45-56. 1970.

A1515 Dimethoate Residues in Winter Spinach. R.E. Menzer and E.D. Thomas. Jour. Econ. Ent. 63(1):311-312. Feb. 1970.

A1516 Rearing and Distribution of Maryland *Culicoides* (Diptera: Ceratopogonidae). Lionel J. Gazeau and Donald H. Messersmith. Mosquito News 30(1):30-34; March 1970.

A1521 Effect of Chlorinated Hydrocarbons in the Diet on the Toxicity of Several Organophosphorus Insecticides. R.E. Menzer. Toxicology and Applied Pharmacology 16:446-452. 1970.

A1522 The Brood-Rearing Capability of Caged Honey Bees Fed Dandelion and Mixed Pollen Diets. E.W. Herbert, W.E. Bickley, and H. Shimanuki. Jour. Econ. Ent. 63(1):215-218. Feb. 1970.

A1532 Recovery of the Braconid Parasite *Microctonus aethiops* from the Alfalfa Weevil after Hormonal Treatment. John W. Neal, Jr., William E. Bickley, and Carl C. Blickenstaff. Jour. Econ. Ent. 63(2):681-682. April 1970.

A1541 Degradation of Disulfoton and Phorate in Soil Influenced by Environmental Factors and Soil Type. R.E. Menzer, E.L. Fontanilla, and L.P. Ditman. Bulletin Environmental Contamination and Toxicology 5(1):1-5. 1970.

A1547 Natural Precipitating Proteins in Insect Hemolymph. Howard R. Bullock and Allen L. Steinhauer. Jour. Insect Physiol. 16:595-600. 1970.

A1548 Characters for Separating Late-State Larvae, Pupae, and Adults of *Alphitobius diaperinus* and *A. laevigatus* (Coleoptera: Tenebrionidae). F.J. Preiss and J.A. Davidson. Annals Ent. Soc. Amer. 63(3):807-808. May 1970.

A1551 A New Crenulaspidiotus from Arizona (Homoptera: Diaspididae). John A. Davidson. Proc. Ent. Soc. Washington 72(4):500-503. Dec. 1970.

A1643 Response of *Microctonus aethiops* and *M. colesi*, Parasites of the Alfalfa Weevil, to a Mixture of *cis-trans-* and *trans-trans-* 10, 11-Epoxyfarnesenic Acid Methyl Ester. John W. Neal, Jr., William T. Hollaway, and William E. Bickley. Jour. Econ. Ent. 64(1):338-339. Feb. 1971.

A1649 Metabolism of *O*-Ethyl *S, S*-Dipropyl Posphorodithioate (Mocap) in Bean and Corn Plants. Robert E. Menzer, Zafar M. Iqbal, and George R. Boyd. Agr. and Food Chem. 19(2):351-356. Mar./Apr. 1971.

A1654 Tobacco Flea Beetle Response to Disulfoton on Maryland Tobacco. Floyd P. Harrison. Jour. Econ. Ent. 64(3):766-767. June 1971.

A1657 Microwave Effects on Reproductive Capacity and Genetic Transmission in *Drosophila melanogaster*. T.L. Pay, E.C. Beyer, and C.F. Reichelderfer. Jour. Microwave Power 7(2):75-82. 1972.

A1667 Timing of Insecticide Applications for European Corn Borer Control in Sweet Corn. Floyd P. Harrison and John W. Press. Jour. Econ. Ent. 64(6):1496-1499. Dec. 1971.

A1668 A Study of *Microctonus aethiops* (Nees), a Braconid Parasite of the Alfalfa Weevil, *Hypera postica* (Gyllenhal). John W. Neal, Jr. and William E. Bickley. 62 pp. 1971.

A1670 A New Species of Dioryctria Infesting Loblolly Pine. B.D. Schaber and F.E. Wood. Proc. Ent. Soc. Washington 73(2):215-223. June 1971.

A1671 1970 Apple Disease Control with Massive Dosages of Difolatan. E.R. Krestensen and L.O. Weaver. Trans. Penin. Hort. Soc. 59:51-52. 1971.

A1672 Brood X of the Periodical Cicada - 1970. E.R. Krestensen. Trans. Penin. Hort. Soc. 59:48-50. 1971.

A1674 The Pollination of Cucumbers in Maryland. A.L. Steinhauer. Amer. Bee Jour. III(6):224-225. June 1971.

A1676 Effect of Enzyme Induction on the Metabolism and Selectivity of Organophosphorus Insecticides, Robert E. Menzer, Proc. Second IUPAC International Congress Pesticide Chem., Tel Aviv, 1971. Vol. 1:51-76. 1972.

A1678 An Annotated List of the Mosquitoes of Maryland. William E. Bickley, Stanley R. Joseph, Jerry Mallack, and Robert A. Berry. Mosquito News 31(2):187-190. June 1971.

A1684 Extension of the Distributional Range of *Aedes triseriatus* (Say) to Greenland. Donald H. Messersmith. Mosquito Systematics Newsletter 3(1):7. March 1971.

A1692 Nature of Neutral Phosphorus Ester Metabolites of Phosphamidon Formed in Rats and Liver Microsomes. George W. Lucier and Robert E. Menzer. Jour. Agr. and Food Chem. 19(6):1249-1255. Nov./Dec. 1971.

A1693 A New Species of *Culicoides* from Colombia (Diptera: Ceratopogonidae). Donald H. Messersmith. Proc. Ent. Soc. Washington 74(2):165-169. June 1972.

A1701 Metabolism of *O*-Ethyl *S,S*-Dipropyl Phosphorodithioate in Rats and Liver Microsomal Systems. Zafar M. Iqbal and Robert E. Menzer. Biochemical Pharmacology 21: 1569-1584. 1972.

A1725 A Redescription of *Hemigymnaspis eugeniae* (Lindinger). John A. Davidson. Proc. Ent. Soc. Washington 74(3):316-320. Sept. 1972.

A1733 A Qualitative Method for Estimating the Degree of Engorgement of *Aedes aegypti* Adults. Dana R. Pilitt and Jack Colvard Jones. Jour. Medical Ent. 9(4):334-337. 1972.

A1735 Rearing and Release of *Microctonus aethiops*, a Parasite of the Alfalfa Weevil, in Maryland. William Thomas Hollaway, William E. Bickley, and John W. Neal, Jr. Jour. Econ. Ent. 66(1):164-166. Feb. 1973.

A1748 Accumulation and Persistence of a Nuclear Polyhedrosis Virus of the Cabbage Looper in the Field. E. David Thomas, Charles F. Reichelderfer and Arthur M. Heimpel. Jour. Invertebrate Pathology 20(2):157-164, Sept. 1972.

A1754 A New Host Record for *Forcipomyia crinita* Saunders (Diptera: Ceratopogonidae). Paul G. Bystrak and Donald H. Messersmith. Ent. New 84:17-21. Jan. 1973.

A1769 Biotransformation of Dimethoate by Cell Culture Systems. H.H. North and R.E. Menzer. Pesticide Biochemistry and Physiology 2(3):278-285. Oct. 1972.

A1772 The Effect of Soil pH on the Persistence of Cabbage Looper Nuclear Polyhedrosis Virus in Soil. E. David Thomas, Charles F. Reichelderfer, and Arthur M. Heimpel. Jour. Invertebrate Pathology 21:21-25. 1973.

A1774 A Modified Vaccinator for Inoculating Diet Surfaces for Nuclear Polyhedrosis Virus Production. E. David Thomas and Charles F. Reichelderfer. Jour. Econ. Ent. 65(6):1766. Dec. 1972.

A1784 A Study on the Fecundity of Male *Aedes aegypti*. Jack Colvard Jones. Jour. Insect Physiology 19:435-439. 1973.

A1795 Life History Variations of the Obscure Scale (Homoptera: Diaspididae) on Pin Oak and White Oak in Maryland. M.B. Stoetzel and J.A. Davidson. Annals Ent. Soc. Amer. 66(2):308-311. March 1973.

A1796 An Automated Inoculating Device for a Packaging Machine. E. David Thomas. Jour. Econ. Ent. 66(1):296-297. 1973.

A1822 Persistence, Mobility, and Degradation of C-Dimethoate in Soils. Willa G. Duff and Robert E. Menzer. Environmental Ent. 2(3):309-318. June 15, 1973.

A1855 Metabolism of DDT in Human Embryonic Lung Cell Cultures. Hanson H. North and Robert E. Menzer. Jour. Agr. and Food Chem. 21(3):509-510. 1973.

DEPARTMENT OF HORTICULTURE

Miscellaneous Publications

597 Influence of Selected Herbicide Treatments on Growth of Cantaloupes, Cucumbers and Certain Weed Species Under Field Conditions. J.D. Long and F.C. Stark. Proc. N.E. Weed Control Conf. 21:76-82. 1967.

606 Descriptions of *Pelargonium hortorum* Inbreds, Hybrids, and Breeding Lines Released by the University of Maryland in 1967. Perry E. Nugent and Robert J. Snyder. Geraniums Around the World. April 1967.

649 Herbicide Studies on New Strawberry Plantings. J.D. Long and G.J. Stadelbacher. Proc. N.E. Weed Control Conf. 22:245-248. 1968.

651 Weed Control in Cantaloupes and Cucumbers. J.D. Long. Proc. N.E. Weed Control Conf. 22:216-218. 1968.

652 Herbicide Studies on Transplanted Tomatoes. J.D. Long. Proc. N.E. Weed Control Conf. 22:95-97. 1968.

672 Utilization of Food Industries Wastes. I. Ben-Gera and A. Kramer. Advances in Food Research 17:77-152. 1969. Academic Press.

674 The Relevance of Correlating Objective and Subjective Data. Amihud Kramer. Food Tech. 23(7):66-68. July 1969.

684 Weed Control in Sweet Potatoes. C.D. Altman and J.D. Long. Proc. N.E. Weed Control Conf. 23:12-16. 1969.

690 Tomatoes: Latest Developments in Mechanization of the Harvest. F.F. Angell. Trans. Penin Hort. Soc. 58:11-15. 1968.

737 Correlations Between Subjective and Objective Methods. Amihud Kramer. Proc., II Scandinavian Aroma Symposium, Sandefjord, Norway, Apr. 25, 1969. NAERINGSMIDDELINDUSTRIEN (The Food Industry) 23(½):82-92. 1970.

747 Weed Control in Newly Planted Strawberries. C.D. Altman and G.J. Stadelbacher. Proc. N.E. Weed Control Conf. 24:209-212. 1970.

749 Evaluation of Processing Tomato Varieties. F.F. Angell, B.A. Twigg, and A.L. Adams. Hort. Res. Mimeo HR 50-69, 19 pp. 1969.

752 1969 Evaluation of Herbicides. C.D. Altman. Hort. Res. Mimeo Series HR 38-69, 22 pp. 1969.

756 A Progress Report on Chemical Weed Control in Sweet Potatoes. C.D. Altman and J.D. Long. Trans. Penin. Hort. Soc. 9-14. 1969.

758 Evaluation of Activated Carbon Root Dichlobenil Toxicity Dips for Control of in Nursery Plantings. Thomas J. MacCubbin and Conrad B. Link. Hort. Sci. 5(6):512-514. Dec. 1970.

764 Chemical Growth Regulation for Floricultural Crops. A Review of - The Old and the New. James B. Shanks. The Maryland Florist 164. 9 pp. July, Aug. 1970.

771 Outlook on Food Technology for the 70's. Amihud Kramer. The Asgrow Farmer 24(1):1-3. 1971.

773 1970 Evaluation of Herbicides for Vegetable Crops. C.D. Altman. Hort. Dept. Res. Mimeo Series HR 38-70, 18 pp. Oct. 1970.

778 Evaluation of Processing Tomato Varieties and Lines for Mechanical Harve. F.F. Angell and B.A. Twigg. Hort. Res. Mimeo.

782 Texture–Its Definition, Measurement and Relation to Other Attributes of Food Quality. Amihud Kramer. Symposium on Texture Measurement, IFT, May 25, 1971. Food Tech. 26(1):34-39. 1972.

784 Problems Encountered in Bedding Plant Production. Franklin D. Schales. Trans. Penin. Hort. Soc. pp. 17-19. 1970.

799 Control of Ipomeo L. spp. in Sweet Corn. C.E. Beste. Proc. N.E. Sci. Soc. 26:36-40. 1972.

800 Varietal Response of Sweet Corn to Alachlor and Butylate. F.D. Schales, C.D. Altman, and C.E. Beste. Proc. N.E. Weed Sci. Soc. 26:27-30. 1972.

801 1971 Evaluation of Herbicides for Vegetable Crops. C.E. Beste, C.D. Altman, and J.K. Donohoe. Hort. Res. Mimeo Series HR 38-71, 22 pp. Dec. 1971.

807 Evaluation of Tomato Varieties and Lines for Mechanical Harvesting and Processing Quality. F.F. Angell, B.A. Twigg, and Janice Donohoe. Hort. Res. Mimeo Series HR 58-72, 12 pp. 1972.

809 A Ten-Year Study on Training of Spur-Type Delicious Apple Trees. B.L. Rogers. The Maryland Fruit Grower 42(3):3-9. 1972.

812 Chemical Control of Growth and Flowering in Hibiscus. James B. Shanks. Hort Sci. 7 (6):574. Dec. 1972.

813 The Effects of 2-Chloroethylphosphonic Acid on Yield and Quality of Tomatoes *(Lycopersicon esculentum,* Mill.). G.L. Klingaman, C.W. Reynolds, and F.F. Angell. Hort. Res. Mimeo Series HR 61-72, 8 pp. 1972.

816 Food Texture--Definition, Measurement and Relation to Other Food Quality. Amihud Kramer. Food Tech. 26(1):34-39. 1972.

820 Impact of Changing Quality Requirements. Amihud Kramer. Jour. Amer. Soc. Hort. Sci., HortSci. 8(2):106-120. April 1973.

826 A Complete Quality Control System. A Kramer and T.R. Gormley. Proc. Institute Food Sci. & Tech., (U.K.) 5(3):160-164. 1972.

829 Expanded Tables for Determining Significance of Differences for Ranked Data. G. Kahan, D. Cooper, A Papavasiliou and A. Kramer, Food Tech. 27(5):64-69. 1973.

830 Evaluation of Tomato Varieties and Advanced Lines for Mechanical Harvesting and Processing Quality. F.F. Angell, B.A. Twigg, C.A. McClurg, and Janice Donohoe. Hort. Res. Mimeo HR 58-73. 1973.

833 1972 Evaluation of Herbicides for Vegetable Crops. C.E. Beste. Hort. Res. Mimeo HR 38-72. 1972.

Scientific Articles

A1345 Genotypic-Environmental Interactions for Sweet Corn Hybrids Produced by The Conventional and Cytoplasmic Genetic Male Sterile Methods. R.G. Creech, R.J. Snyder, E.V. Wann, and W.H. Lachman. Crop Sci. 8:380-383. May-June 1968.

A1385 Application of Controlled Atmosphere Storage of Produce to the Household Refrigerator. L.R. Hodgson and A. Kramer. Refrigeration Res. Foundation, Information Bulletin 69-11. 4 pp. Nov. 1969.

A1437 Microbiology of Fresh Apple and Potato Plugs Preserved by Gas Exchange. J.G. Kaffezakis, S.J. Palmer, and Amihud Kramer. Jour. Food Sci. 34:426-429. 1969.

A1506 Internal Can Corrosion by Processed Sweet Potatoes as Affected by Phenolase Activity and Nitrate Concentration. D.A. Smittle and L.E. Scott. Proc. Amer. Soc. Hort. Sci. 94(6):649-654. Nov. 1969.

A1517 The Influence of Light During Vernalization on the Flowering Response of Ajuga and Dianthus. Daniel E. Eltzroth and Conrad B. Link. Jour. Amer. Soc. Hort. Sci. 95(1):95-98. Jan. 1970.

A1529 Tomato Anthracnose: A Hypodermic Inoculation Technique for Determining Genetic Reaction. M. LeRon Robbins and F.F. Angell. Jour. Amer. Soc. Hort. Sci. 95(1):118-119. Jan. 1970.

A1531 Relation of Rheological Properties of Testa of *Pisum sativum* L. to Histological Changes. Samuel Angel and Amihud Kramer. Jour. Texture Studies 1:90-108. 1969.

A1535 Measurement and Partial Characterization of Pectinesterase in Apple Fruits. Y.S. Lee and R.C. Wiley. Jour. Amer. Soc. Hort. Sci. 95(4):465-468. July 1970.

A1546 Objective Evaluation of Canned Tuna Quality. Jamshid Rasekh, Amihud Kramer, and Roland Finch. Jour. Food Sci. 35:417-423. 1970.

A1549 Influence of Light and Temperature Upon Leaf and Bract Abscission in Poinsettia. J.B. Shanks, W.E. Noble, and W.T. Witte. Jour. Amer. Soc. Hort. Sci. 95(4):446-449. July 1970.

A1557 Tomato Anthracnose: Inheritance of Reaction to *Colletotrichum coccodes* in Lycopersicon Spp. M. LeRon Robbins and F.F. Angell. Jour. Amer. Soc. Hort. Sci. 95(4):468-471. July 1970.

A1560 Modifying Texture of Processed Apple Slices. R.C. Wiley and Y.S. Lee. Food Tech. 24(10):126-128. 1970.

A1607 Efficient Detection of Asparagus Monoploids for the Production of Colchiploid Inbreds. M.J. Bassett, R.J. Snyder, and F. F. Angell. Euphytica 20:299-301. May 1971.

A1617 Quantitative Determination of Composition of Models of Food Systems by the Infrared Attentuated Total Reflectance Technique. J.M. Wilson, I. Ben-Gera, and A. Kramer. Jour. Food Sci. 36:162-165. 1971.

A1621 Freeze Concentration by Directional Cooling. Amihud Kramer, Kohmei Wani, James H. Sullivan, and Ilan Shomer. Jour. Food Sci. 36:320-322. 1971.

A1644 Gas Chromatographic Profiles of Stored Carrots. J. Rasekh and A. Kramer. Jour. Amer. Soc. Hort. Sci. 96(5):572-575. Sept. 1971.

A1683 Uni-directional and Multi-directional Freezing Rates of Selected Foodstuffs. Amihud Kramer, J.H. Sullivan, and Kohme Wani. Proc. XIII International Congress Refrigeration 3:381-385. 1971.

A1688 Palatability, Wholesomeness, and Nutritive Value of Frozen Prepared Foods as Influenced by Methods of Thawing and Heating. Velma E. Harwood, Amihud Kramer, and Leonard S. Fenn. Proc. XIII International Congress Refrigeration 3:377-380. 1971.

A1695 Effects of Vernalization and Forcing Photoperiod on Growth and Flowering of the Easter Lily *(Lilium longiflorum* Thunb. 'Harson'). Alton J. Pertuit, Jr. and Conrad B. Link. Jour. Amer. Soc. Hort. Sci. 96(6):802-804. 1971.

A1696 Histological and Histochemical Studies of Sweet Corn (*Zea mays* L.) Pericarp as Influenced by Maturity and Processing. Tannous Khalil and Amihud Kramer. Jour. Food Sci. 36:1064-1069. 1971.

A1704 Competition and Survival in Female Plants of *Asparagus officinalis* L. J.C. Bouwkamp and J.E. McCully. Jour. Amer. Soc. Hort. Sci. 97(1):74-76. Jan. 1972.

A1706	Solution Culture Investigations of the Influence of Manganese, Calcium, Boron, and pH on Internal Bark Necrosis of Delicious Apple Trees. R.E. Cooper and A.H. Thompson. Jour. Amer. Soc. Hort. Sci. 97(1):138-141. 1972.
A1712	Control of Soft Rot *(Rhizopus* sp.*)* in Cut Root Pieces of Sweet Potatoes with 2,6-dichloro-4- nitroaniline. J.C. Bouwkamp, L.E. Scott, and J.G. Kantzes. Plant Disease Reporter 55(12):1097-1099. Dec. 1971.
A1713	Palatability and Nutritive Value of Fresh, Canned, and Frozen Collard Greens. Jean W. Smith and Amihud Kramer. Jour. Amer. Soc. Hort. Sci. 97(2):161-163. 1972.
A1716	Practical Approach to Flavor Development. A. Allen Bednarczyk and Amihud Kramer. Food Tech. 25(11):24-33. 1971.
A1727	The Effects of 2-Chloroethylphosphonic Acid on Yield and Quality of Tomatoes (Lycopersicon esculentum, Mill). G.L. Klingaman, C.W. Reynolds, and F.F. Angell. Hort. Res. Mimeo HR 61-72. 1972.
A1741	Production of Sweet Potatoes from Root Pieces. J.C. Bouwkamp and L.E. Scott. HortSci. 7(3):271-272. June 1972.
A1749	The Toxicity of Acetaldehyde Vapors to Postharvest Pathogens of Fruits and Vegetables. Yair Aharoni and Glenn J. Stadelbacher. Phytopathology 63(4):544-545. April 1973.
A1759	Effect of Various Endosperm Mutants on Oil Content and Fatty Acid Composition of Corn (*Zea mays* L.). L.F. Flora and R.C. Wiley. Jour. Amer. Soc. Hort. Sci. 97(5):604-607. 1972.
A1763	Three Years' Results with Chemical Thinning of Peaches with (2-chloroethyl) Phosphonic Acid. A.H. Thompson and B.L. Rogers. Jour. Amer. Soc. Hort. Sci. 97(5):644-647. Sept. 1972.
A1765	Rapid Determination of "Skin-toughness" in Sweet Potato. J.C. Bouwkamp, L.E. Scott and W.L. Harris. Hort Sci. 7(5):473-474. Oct. 1972.
A1781	Clonal Differences in the Incidence of Surface Rot (*Fusarium* spp.) on Sweetpotato. L.E. Scott, James Kantzes and John C. Bouwkamp. Plant Disease Reporter 56(9):783-784, Sept. 1972.
A1787	Quantitative Determination of Fat, Protein and Carbohydrates of Soy Products with Infrared Attenuated Total Reflectance. John M. Wilson, A. Kramer, and I. Ben-Gera. Jour. Food Sci. 38:14-17. 1973.
A1789	Changes in Quality and Nutritional Composition of Foods Preserved by Gas Exchange. Tovah Besser and Amihud Kramer. Jour. Food Sci. 37:820. 1972.
A1791	Effects of Freezing and Packaging Methods on Shrinkage of Hams in Frozen Storage. B.H. Ashby and G.M. James. Jour. Food Sci. 38:254-257. 1973.
A1828	Effects of Freezing and Packaging Methods on Freezer Burn of Hams in Frozen Storage. B.H. Ashby and G.M. James. Jour. Food Sci. 38:258-260. 1973.
A1842	Evaluation of Herbicides in No-Till Planted Cucumbers, Tomatoes, and Lima Beans. C.E. Beste. Proc. N. E. Weed Sci. Soc. 27:232-239. 1973.

Technical Bulletins

A162	Developmental Rates and Biosynthesis of Carotenoids in Tomatoes as Influenced by Two Solar Radiation Levels. B.D. Horton and F.C. Stark. 19 pp. Nov. 1969.
A166	Internal Bark Necrosis of the Apple as Influenced by Calcium Placement and Soil Manganese. D.C. Ferree and A.H. Thompson. 51 pp. June 1970.

COLLEGE OF HUMAN ECOLOGY

Scientific Articles

A1510 Effect of Storage and Other Variables on Composition of Frozen Broccoli. Mary S. Eheart. Food Tech. 24(9):69-71. Sept. 1970.

A1592 Storage of Fresh Broccoli and Green Beans. Effects on Ascorbic Acid, Sugars, and Total Acids. Mary S. Eheart and Dianne Odland. Jour. Amer. Dietetic Assoc. 60(5):402-406. May 1972.

A1600 Nitrogen Balance of Young Women Fed Peanut Flour Equalized to the FAO Pattern. Lillian C. Butler, Virginia T. Dawson, and Yvonne L. Adams. Federation Proceedings 29(2):821. March- April 1970.

A1627 Utilization of Peanut Flour Equalized to the FAO Pattern. Lillian C. Butler, Virginia T. Dawson, and Yvonne L. Adams. Amer. Jour. Clinical Nutrition 23(9):1169-1174. Sept. 1970.

A1779 Use of Ammonium Compounds for Chlorophyll Retention in Frozen Green Vegetables. M.S. Eheart and D. Odland. Jour. Food Sci. 38:202-205. 1973.

DEPARTMENT OF POULTRY SCIENCE

Miscellaneous Publications

711 Methods of Calculating, Estimating, and Predicting Physical and Thermodynamic Properties of Various Compounds. A Literature Review. R.D. Creek. Multilithed Circular, 12 pp. 1969.

722 Least Cost Energy. E. Hoffmann. Feedstuffs 41(27):15. July 5, 1969.

761 Antoine Constants for Vapor Pressure Equations of Organic Acids of Biological Significance. R.D. Creek. Multilithed Circular, 6 pp. June 1970.

762 Antoine Constants for Vapor Pressure Equations of n-alcohols, Isopropopanol, t-butanol, Glycerol, Formaldehyde, Acetaldehyde, and Acetone. R.D. Creek. Multilithed Circular, 6 pp. July 1970.

766 Problems in the Axenic Culturing of Trichomonads. Mary S. Shorb. Multilithed Circular, 13 pp. Oct. 1970.

767 Factors Which Delay or Are Associated with the Delay of Sexual Maturity of Layer or Breeder Hens - A Literature Review. R.D. Creek. Multilithed Circular, 36 pp. Sept. 1970.

768 Some Facts About the Physical, Chemical, and Thermodynamic Properties of Water and a Review of the Literature Concerning Water and Fowl. R.D. Creek. Multilithed Circular, 22 pp. Sept. 1970.

777 The Fallacy of Equivalence in the Methionine to Cystine Conversion in Chickens, Its Implications, and Handling of the Problem. R.D. Creek. Feedstuffs 43(9):22. Feb. 27, 1971.

787 The Methionine - Cystine Conversion. R.D. Creek. Feedstuffs 43(31):22. July 31, 1971.

791 Poultry Science Departments: Unconsolidated vs. Consolidated. D.E. Bigbee and C.S. Shaffner. Poultry Sci. LI(4):1175-1180. July 1972.

794 Influence of Light on Quality of Broilers Grown in Windowless Houses. Charles J. Wabeck and James L. Heath (Poultry Sci.); Kenneth E. Felton (Agr. Engin.). Proc. D.P.I. Housing Conf., Sept. 1971. 12 pp.

Scientific Articles

A1460 Chicken Serum Alkaline Phosphatase Isozymes and Egg Production. H.A. Engh and F.H. Wilcox. Poultry Sci. 50(2):346-349. March 1971.

A1504 The Effects of Gonadal Hormones on Hyperossification in the Domestic Fowl. George J. Mulkey and Edward F. Godfrey. Poultry Sci. 48(4):1414-1420. July 1969.

A1511 The Effect of a High Level of Lithium Carbonate on Egg Shell Formation of Laying Hens. Norman Mills, Jr., N.V. Helbacka, and R.D. Creek. Poultry Sci. 48(5):1766-1767. Sept. 1969.

A1512 Studies of Protein Digestion in the Chicken. I. Investigation of Apparent Amino Acid Digestibility of Fish Meal Protein Using Cecectomized, Adult Male Chickens. W.L. Payne, R.R. Kifer, D.G. Snyder, and G.F. Combs. Poultry Sci. 50(1):143-150. Jan. 1971.

A1530 The *In Vitro* Uptake of Tritiated Oestradiol by the Oviduct of Immature and Laying Chickens. Helen C. Cecil, J. Bitman, and C.S. Shaffner. Acta Endocrinologica (Kobenhavn) 63:265-274. 1970.

A1544 Mathematical Analysis of Energy-Nutrient Relationships. 1. Protein and Energy. Richard D. Creek. Poultry Sci. 49(1):29-33. Jan. 1970.

A1556 Oviducal Water, Electrolytes and Nucleic Acids of Laying and Nonlaying Hens and of Estradiol Stimulated Pullets. Helene C. Cecil and J. Bitman (ARS, USDA), C.S. Shaffner (Univ. of Md.). Poultry Sci. 49(2):467-475. March 1970.

A1566 Performance of Mated Versus Non-mated Coturnix Quail. Edward F. Godfrey. Poultry Sci. 49(1):318-319. Jan. 1970.

A1567 Production of an Artifact During Methanolysis of Lipids by Boron-trifluoride Methylation. Winifred Knuese Fulk and Mary S. Shorb. Jour. Lipid Research 11:276-277. 1970.

A1568 The Relationship Between Embryonic and Postnatal Growth in Japanese Quail. Maie Fouad M. Ali and Edward F. Godfrey. Poultry Sci. 49(1):320-321. Jan. 1970.

A1595 Lipotropic Agents in Broiler Breeder Rations. E.H. Bossard and G.F. Combs. Poultry Sci. 49(2):599-601. March 1970.

A1624 The Toxicity of Trimethylene Glycol for the Chick. R.D. Creek. Poultry Sci. 49(6):1686-1687. Nov. 1970.

A1642 The Effect of Lithium Carbonate on Egg Shell Formation and Serum Calcium Level of the Hen. R.D. Creek, Pauline Lund, O.P. Thomas, and W.O. Pollard. Poultry Sci. L(2):577-580. March 1971.

A1645 Lipids of Male and Female *Ascaridia galli* at Different Ages. Winifred Knuese Fulk and Mary S. Shorb. Jour. Parasitology 57(4):840-844. Aug. 1971.

A1656 Pigmentation of Broiler Tissues Carcasses. J.L. Heath. Proc. 1971 Maryland Nutr. Conf. pp. 74-77. 1971.

A1685 Serum Cathepsin Level of Chickens: Repeatability and Influence of Age. F.H. Wilcox. Poultry Sci. Res. Note 50(3):980-981. May 1971.

A1686 Cathepsin Level in Various Organs of the Chicken. F.H. Wilcox. Poultry Sci. 50(5):1514-1515. Sept. 1971.

A1709 The Effect of Dietary Soybean Oil on the Deposition of Xanthophyll in Broiler Skin. J.L. Heath and C.S. Shaffner. Poultry Sci. 51(2):502-506. March 1971.

A1719 Bone Strength of Broilers Reared in Floor Pens and in Cages Having Different Bottoms. C.J. Wabeck (Univ. of Md.) and L.H. Littlefield (USDA). Poultry Sci. 51(3):897-899. May 1972.

A1720 Feed and Water Withdrawal Time Relationship to Processing Yield and Potential Fecal Contamination. C.J. Wabeck. Poultry Sci. L1(4):1119-1121. July 1972.

DEPARTMENT OF VETERINARY SCIENCE

Scientific Articles

A1371 Effect of Triton WR-1339 on Rous Virus-Induced Tumors in Chickens. Vernon W. Mayer and Frank M. Hetrick. The Cornell Verterinarian 59(3):405-417. July 1969.

A1472 Experimental Exposure of Calves to a Bovine Rhinovirus. S.B. Mohanty, M.G. Lillie, T.F. Albert, and B. Sass. Amer. Jour. Vet. Res. 30(7):1105-1111. July 1969.

A1476 Relationship of Infectious Bovine Keratoconjunctivitis Virus to the Virus of Infectious Bovine Rhinotracheitis. Sashi B. Mohanty and Mary G. Lillie. The Cornell Veterinarian LX(1):3-9. Jan. 1970.

A1488 A Case of Eisenmenger Complex in a Calf. Bernard Sass and Thomas F. Albert. The Cornell Veterinarian LX(1):61-65. Jan. 1970.

A1501 Paratypgoid in a Barn Owl. Louis N. Locke and John A. Newman. Chesapeake Sci. 11(1):67-68. March 1970.

A1502 Titration of Infectious Bronchitis Virus in Tracheas of Susceptible and Immune Chickens. R.B. Johnson, J.A. Newman, and F.K. Wills. Avian Diseases 13(3):632-635. August 1969.

A1518 Lymph Node Hyperplasia in a Congenitally Deformed Bull Inoculated at Birth with Bovine Lymphosarcoma Material. Basil C. Hatziolos. Bulletin Hellenic Vet. Medical Soc. 20(3):125-135. 1969.

A1559 Type 2 Bovine Adenovirus as an Adventitious Contaminant in Primary Bovine Embryonic Kidney Cell Cultures. Sashi B. Mohanty and Mary G. Lillie. Applied Microbiology 19(2):381-382. Feb. 1970.

A1580 The Effect of Urethan on Newborn Calves. Basil C. Hatziolos. Zbl. Vet. Med. A, 17:743-756. Oct. 1970.

A1639 The Measurement of the Antigenic and Pathogenic Variability of Infectious Bronchitis Virus Strains by Tracheal Culture Techniques. R.B. Johnson and J.A. Newman. Avian Diseases 15(2):233-241. April-June 1971.

A1640 Effect of Urethan on Calves Inoculated with Blind-Passed Bovine Lymphosarcoma Material. Basil C. Hatziolos. Amer. Jour. Vet. Res. 32(7):1007-1018. July 1971.

A1647 A Direct Complement Fixation Test for Detection of Mycoplasma Antibodies in Chicken Serum. W.W. Marquardt and J.A. Newman. Avian Diseases 15:139-149. Jan.-March 1971.

A1650 A New Bovine Herpesvirus and Its Effect on Experimentally Infected Calves. S.B. Mohanty, R.C. Hammond, and M.G. Lillie. Archiv fur die gesamte Virusforschung 34:394-395. 1971.

A1666 Intracellular Localization and Sequential Development of Infectious Bovine Rhinotracheitis Viral Antigens. K.W. Theil, Sashi B. Mohanty, and F.M. Hetrick. Amer. Jour. Vet. Res. 32(12):1955-1962. Dec. 1971.

A1680 Comparative Study of Bovine Adenoviruses. S.B. Mohanty. Amer. Jour. Vet. Res. 32(12):1899-1905. Dec. 1971.

A1681 Effect of Poly I:C on Infectious Bovine Rhinotracheitis Virus Infection in Calves. K.W. Theil, S.B. Mohanty, and F.M. Hetrick. Proc. Soc. Experimental Biology and Medicine 137(4):1176-1179. Sept. 1971.

A1711 Radial Immunodiffusion: A Simple and Rapid Method for Detection of Marek's Disease Antigen(s). W.W. Marquardt. Applied Microbiology 23(5):942-945. May 1972.

A1743 Natural Infection with Infectious Bovine Rhinotracheitis Virus in Goats. S.B. Mohanty, M.G. Lillie, N.P. Corselius, and J.D. Beck. Jour. Amer. Vet. Medical Assoc. 160(6):879-880. March 15, 1972.

A1746 Urethan Injections in Newborn Calves Inoculated with Murine Lymphosarcoma Material. Basil C. Hatziolos. Zentral Brlatt Fur Veterinarmedicin. Zbl. Vet. Med. B, 19:356-378. 1972.

A1753 Outbreaks of Infectious Bronchitis in Vaccinated Broilers on the Delmarva Peninsula. R.B. Johnson, I.M. Moulthrop, and J.A. Newman. Avian Diseases 16(4):828-832. July-Sept. 1972.

A1755 A Modified Direct Complement-Fixation Test for Detection of Marek's Disease Antibodies in Chicken Serum. W.W. Marquardt and J.A. Newman. Avian Diseases 16(5):986-996. Oct.-Dec. 1972.

A1766 Bovine Lymphosarcoma: The Effect of Inoculations on Newborn Calves. III. Fifth and Sixth Years of Observation. Basil C. Hatziolos. Zbl. Vet. Med. B, 19:697-717. 1972.

A1783 Cerebral Nematodiasis in a Red Squirrel. Ronald L. Schueler. Jour. Wild-life Diseases 9:58-60. Jan. 1973.

A1792 Avian Complement-Fixation. Warren W. Marquardt. Avian Diseases 17(1):236-250. Jan.-March 1973.

A1794 Effects of an Experimentally Induced Herpesvirus Infection in Calves. S.B. Mohanty, M.G. Lillie, and A.L. Ingling. Jour. Amer. Veterinary Medical Assoc. 161(9):1008-1011. 1972.

FINANCIAL STATEMENT – JULY 1, 1969 TO JUNE 30, 1970

	Federal Funds			
	Hatch Amended	Regional Research	McIntire-Stennis Forestry	
Appropriations 1969 – 1970	$594,200.00	$185,465.00	$41,242.00	
Receipts from sources other than Federal 1969 – 1970				
State Appropriations for Agricultural Investigations				$2,287,219.00*
Special Endowments, Fellowships and Grants				56,098.56
Sales and Miscellaneous				299,609.32
Total				$2,642,926.88
Balance brought forward July 1, 1969				38,015.53
Grand Total				$2,680,942.41
Expenditures:				
Personal Services	$493,835.38	$ 89,842.24	$29,192.11	
Travel & Transportation	2,156.38	7,278.75	585.20	
Equipment	47,175.36	32,821.53	1,166.67	
Lands & Structures	1,082.94	0	0	
Supplies, materials, other	49,949.94	55,522.48	4,058.86	
Total	$594,200.00	$185,465.00	$35,002.84	
Balance on June 30, 1970			15,476.30	
Grand Totals	$594,200.00	$185,465.00	$50,479.14**	

* Including Offset Funds

** Includes $15,476.30 Carryover Funds

FINANCIAL STATEMENT – JULY 1, 1970 TO JUNE 30, 1971

	Federal Funds			
	Hatch Amended	Regional Research	McIntire-Stennis Forestry	
Appropriations 1970 – 1971	$655,665.00	$213,163.00	$48,973.00	
Receipts from sources other than Federal 1970 – 1971				
State Appropriations for Agricultural Investigations				$2,408,353.00*
Special Endowments, Fellowships and Grants				30,380.57
Sales and Miscellaneous				254,806.31
Total				$2,693,539.88
Balance brought forward July 1, 1970				37,991.69
Grand Total				$2,731,531.57
Expenditures:				
Personal Services	$535,949.20	$106,472.21	$30,284.72	
Travel & Transportation	2,296.46	8,223.93	1,354.49	
Equipment	34,540.47	69,433.08	8,729.41	
Lands & Structures	0	0	0	
Supplies, materials, other	82,878.87	29,033.78	8,160.15	
Total	$655,665.00	$213,163.00	$48,528.77	
Balance on June 30, 1971			18,163.07	
Grand Totals	$655,665.00	$213,163.00	$66,691.84**	

* Including Offset Funds

** Includes $18,163.07 Carryover Funds

FINANCIAL STATEMENT – JULY 1, 1971 TO JUNE 30, 1972

	Federal Funds			
	Hatch Amended	Regional Research	McIntire-Stennis Forestry	
Appropriations 1971 – 1972	$692,022.00	$229,949.00	$52,372.00	
Receipts from sources other than Federal 1971 – 1972				
State Appropriations for Agricultural Investigations				$2,501,263.00*
Special Endowments, Fellowships and Grants				25,255.12
Sales and Miscellaneous				246,093.00
Total				$2,772,611.12
Balance brought forward July 1, 1971				16,420.02
Grand Total				$2,789,031.14
Expenditures:				
Personal Services	$601,187.47	$115,750.84	$37,140.01	
Travel & Transportation	5,172.43	8,155.42	494.76	
Equipment	28,153.26	39,851.84	5,512.71	
Lands & Structures	0	0	0	
Supplies, materials, other	57,508.84	66,190.90	9,063.75	
Total	$692,022.00	$229,949.00	$52,211.23	
Balance on June 30, 1972			18,323.84	
Grand Totals	$692,022.00	$229,949.00	$70,535.07**	

* Including Offset Funds

** Incluses $18,323.84 Carryover Funds

FINANCIAL STATEMENT – JULY 1, 1972 TO JUNE 30, 1973

	Federal Funds			
	Hatch Amended	Regional Research	McIntire-Stennis Forestry	
Appropriations 1972 – 1973	$721,853.00	$245,029.00	$72,160.00	
Receipts from sources other than Federal 1972 – 1973				
State Appropriations for Agricultural Investigations				$2,665,862.00*
Special Endowments, Fellowships and Grants				27,115.59
Sales and Miscellaneous				226,000.00
Total				$2,918,977.59
Balance brought forward July 1, 1972				7,709.79
Grand Total				$2,926,687.38
Expenditures:				
Personal Services	$628,858.98	$145,784.63	$45,449.33	
Travel and Transportation	3,979.63	9,142.03	706.95	
Equipment	35,676.43	38,944.52	7,220.88	
Lands and Structures	0	0	0	
Supplies, Materials, Other	53,337.96	51,157.82	10,224.91	
Total	$721,853.00	$245,029.00	$63,602.07	
Balance on June 30, 1973			26,881.77	
Grand Totals	$721,853.00	$245,029.00	$90,483.84**	

* Including Offset Funds

** Includes $26,881.77 Carryover Funds

Date

DO NOT CIRCULATE

In addition to state and federal funds, the research program of the University of Maryland Agricultural Experiment Station has received support during the year from many public, private and industrial organizations and individuals. It is regretted that space does not permit recognition of all sources of help, but the cooperation of all is herewith gratefully acknowledged.